STRUCTURAL CHANGES IN CROPPING PATTERN IN SELECTED TAHSILS OF WARDHA DISTRICT

THESIS

Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
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DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the thesis entitled **"STRUCTURAL CHANGES IN CROPPING PATTERN IN SELECTED TAHSILS OF WARDHA DISTRICT"** or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or Scientific Organization. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.

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CERTIFICATE

This is to certify that the thesis entitled **"STRUCTURAL CHANGES IN CROPPING PATTERN IN SELECTED TAHSILS OF WARDHA DISTRICT"** submitted in partial fulfillment of the requirements for the degree of "**Master of Science in Agriculture (Agril. Economics)"** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafied research work carried out by **Manwar Madhuri Khushal** under my guidance and supervision.

The subject of thesis has been approved by the Student's Advisory Committee.

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Date :

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THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE INCLUDING EXTERNAL EXAMINER (AFTER VIVA–VOCE)

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Place: Akola (**Manwar Madhuri Khushal)**

Date: Enrollment No. JJ/1137

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(A) List of Tables

(B) List of Figure

(C) Abbreviations

%	-	Per cent
/	-	Per
@	-	At the rate
Agril.	-	Agricultural
APC	-	Agricultural Prices and Costs Scheme
CGR	-	Compound Growth Rate
CV	-	Coefficient of Variation
Dr. PDKV	-	Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
e.g.	-	Exampli gratia (For example)
et al.	-	Et alia (and other)
etc.	-	Etcetera
Fig	-	Figure
Ha	-	Hectare
i.e.	-	That is
J	-	Journal
Kgs	-	Kilogram
M.S.	-	Maharashtra State
Mha	-	Million hectare
No.	-	Number (s)
Viz.	-	Videlicet (Namely)
Sr. No.	-	Serial number

(D) Thesis Abstract

a) Title of the thesis	**:**	**"STRUCTURAL CHANGES IN CROPPING PATTERN IN SELECTED TAHSILS OF WARDHA DISTRICT"**
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ABSTRACT

The research entitled "Structural changes in cropping pattern in selected tahsils of Wardha district" was carried with objectives to study the changes in cropping pattern, to study the growth and instability of major crops, to study the crop diversification, to study the structural changes in

cropping pattern, to identify the advantageous crops in selected tahsils of Wardha district.

The present study was based on secondary data collected from various government publications and pertains to a period of 10 years i.e. from 2005-06 to 2014-15. The present study has examine the changes in cropping pattern, the growth and instability of major crops, the trend of crop diversification, structural changes in cropping pattern and advantageous crops in selected tahsils of Wardha districts. Simple tabular analysis was used to examine the changes in cropping pattern in selected tahsils of Wardha district i.e., Arvi, Ashti, Devali and Samudrapur. The area under cotton is found to be increasing over the period of study while area of kharif jowar, soybean, mung and udid had reduced in selected tahsils of Wardha district. The growth rates of area of major crops were estimated. Coefficient of variation and Coppocks instability index were used to study the instability of major crops in selected tahsils of Wardha district. Herfindal index and Entropy index have used to study the crop diversification, which analyzed that crop diversification from subsistence crops to more commercial crops took place in selected tahsils of Wardha district. Markov chain analysis was used to study the structural changes in cropping pattern in selected tahsils of Wardha district. Cotton and soybean retained their previous years' area share. The areas of kharif jowar, mung and other crops have been shifted to cotton. In order to identify the advantageous crops, land concentration ratio in selected tahsils of Wardha district with comparative advantage was computed during the study period. Cotton attained prestigious position in the copping pattern of selected tahsils of Wardha district. Cotton shows increasing land concentration ratio, so cotton is most advantageous crop in Arvi, Ashti, Devali and Samudrapur tahsils of Wardha district.

CHAPTER I

INTRODUCTION

1.1 Background Information

Agriculture has always been the backbone of the Indian economy and despite concerted industrialization in the last six decades; agriculture still occupies a place of pride. It provides employment to around 60 percent of the total workforce in the country. The significance of agriculture in India arises also from the fact that the development in agriculture is an essential condition for the development of the national economy. Agriculture sector is the principal source of food for consumption for non-agricultural workers. (Hrideshwer Gupta 2013).

Advancement of technology in different fields and increasing exploitation of irrigation sources, development of varieties of seed, changing market and other infrastructure has led to continuous reallocation of land resources towards different crops. Sometimes a new cropping pattern is practice in view earning more. The present problem faces the farmer therefore, lies in the design making about the profitable levels of diversification of crop farming or choice of crop to be grown on limited plots that can probably give the optimal level of profit and also meet their daily requirement. With the passage of time farmer becoming increasingly commercialized and started farming for maximizing their farm output. Now day's farmers have realized the need for emphasizing more on the long term net return. Due to economic importance the analysis of crop diversification has been a considerable interest to the agro-economist.

Diversification is an integral part of process of structural transformation of and economy within agriculture, the sub sector like Horticulture, Forestry and Animal husbandry progressively occupy a more significant role as compared to crop production.

To meet the challenges of a globalizing market in agriculture as well as the growing and changing needs of the population in South East Asia have undertaken crop diversification to enhance productivity and

cultivate high value crop with positive outcome. These countries are gradually diversifying their crop sector in favour of high value commodities, especially fruits, vegetables and spices. Diversification is taking place either through area augmentation or by crop substitution. If carried out appropriately, diversification can be used as a tool to augment farm income, generate employment, alleviate poverty and conserve precious soil and water resources.

The cropping pattern of a region reveals the proportion of area of land under different crops at a point of time, the rotation of crops and the area under different crops. The cropping pattern changes in space and time. In fact, no cropping pattern can be good and ideal for all times to come. The cropping system of a region is decided by and large, by different types of soil and climatic parameters (overall agro-ecological setting for nourishment and appropriateness of a crop or a set of crops for cultivation. Nevertheless, at the farmer's level, potential productivity and monetary benefits act as guiding principles while opting for a particular crop/cropping system. These decisions with respect to choice and cropping systems are further narrowed down the influence of several other forces related to infrastructure facilities, socio-economic factors and technological developments, al operating interactively at micro-level. The prevalent cropping system of any locality is, therefore, the cumulative result of the past and present decisions by individuals, communities or governments and their agencies. The cropping pattern plays a vital role in determining the level of agricultural production and reflects the agricultural economy of an area or region. A change or shift in cropping pattern implies a change in the proportion of area under different crops which depends, to a large extent, on the facilities available to raise crops in the given agro-climatic setting. Moreover, the natural, social, economic and historical factors which determine the cropping pattern of a region, the cropping pattern also changes in consonance with the government policies and technological innovations especially in agriculture.

Crop diversification is a strategy to maximize the use of land, water and other resources and for the overall agricultural development in

the country. It provides the farmers with viable options to grow different crops on their land. The diversification in agriculture is also practiced with a view to avoid risk and uncertainty due to climatic and biological vagaries. It minimizes the adverse effects of the current system of crop specialization and monoculture for better resource use, nutrient recycling, risk reduction and uncertainty and better soil conditions. It also provides better economic viability with value-added products and improvement of ecology.

Cropping pattern is defined as a combination of agricultural crops that are grown in a particular geographical area. It can be viewed either in terms of the area allocated for each crop, or, by the production composition in value terms for any specific area. Therefore, changes in cropping pattern can be seen as the changes in proportion of acreage or the value of production under different crops to total agricultural area or production. The cropping pattern usually changes over time with the development of agriculture, as evident in the case of agriculture in India (Vyas, 1996).

It is a well noted fact that the growth of agricultural production depends on both acreage and productivity growth. Productivity growth can be further decomposed into two parts. One is the yield growth and other is the cropping pattern change. The former measures the impact of changes in output per unit area, while, the latter captures the shift of acreage from crops with relatively low values of output per unit of area to higher value crops.

Cropping patterns are the yearly sequence of crops grown and the spatial arrangement of crops. It is formulated within view to obtained maximum crop production under given situation. Cropping patterns are dynamic and changes over with changes in factors of production and physiological and social environments. Modifications made in cropping pattern are always to derive the maximum benefit from changed crop growing conditions. Indian agriculture has been diversifying during the last two decades towards High-Value Commodities (HVCs) i.e., fruits, vegetables, milk, meat, and fish products. The pace has been accelerated during the decade of 1990s. HVCs account for a large share in the total

value of agricultural production. Supply and demand side factors coupled with infrastructural development and innovative institutions drive these changes. India is a country of about one billion people. Due to the challenge of feeding of our vast population and the experience of food shortages in the pre-independence era (prior to 1947), 'self reliance' in food grains has been the cornerstone of our policies in the last 50 years.

Crop diversification in India is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops. It is intended to give a wider choice in the production of variety of crops in a given area so as to expand production related activities on various crops and also to lessen risk.

Sustainable growth of the agriculture depends considerably on the process of agricultural transformation, which in turn is well connected with shift in production patterns i.e., on the extent of crop diversification. The importance of crop diversification becomes more pertinent particularly as a strategy to reduce inconsistency in agricultural production and yield. In essence, crop diversification helps the farmers in reducing variability in income, sustaining a reasonable income level and mitigating drought and enhancing water use efficiency.

Crop Diversification is a concept opposite to specialization, providing the relative areal strength between crops grown in region. It is an agricultural technique where farmers harvest a variety of crops instead of just one. Crop diversification patterns have great relevance in the agricultural land use studies, and are an important component of the crop geography of a region. Though rich farmers prefer specialization, the poor and substitute farmers are interested in diversification of crops. Diversified crops tend to be more persistent. Diversification enhances nitrogen in the soil to replenish the soil fertility. Thus, it increases the sustainability of arable land. It generates more employment as the agricultural workers remain busy in sowing, weeding, harvesting and marketing of crops through the year. Increase in density of cultivation and in yield per unit area is the only available options to meet future food needs to an ever

increasing population. Farmers and their families benefit from greater variety in their diet, and therefore better nutrition.

Changes in cropping pattern in terms of acreage allocation among different crops have been the integral part of agricultural development of a region, which further depends on the money invested, production, available time, etc. Crop diversification of a geographical area is based on physical, social and economic factors along with technological, geographical and institutional structure of that region.

Maharashtra is an important state and has been considered as one of the progressive state in India. In India, it is the second largest state in population and third geographical area. Since its formation in 1960, the state has secured higher growth rate vis-à-vis faster pace. Planning commission's assessment indicates that the average annual growth rate of Maharashtra would be 10 per cent. It was envisaged that the growth rate could be achieved by adopting comprehensive policy package and institutional reforms.

Geographically the state has 37.58 lakh hectares of land. Out of which 20.13 per cent and 53.90 per cent are under forest and the net sown area respectively. With the population pressure it may not be possible to bring any more acreage of land under cultivation. The population of state is 11.23 crore (2011 census) out of this nearly 54.77 per cent lives in rural area. The growth rate of population over the previous census (2001 census) is around 10.3 and 23.7 per cent in the rural and respectively with the male female ratio of 1000:925 and overall literacy percentage is 82.91. The higher growth rate in the urban area may indicate some shift of rural population to urban area in search of work, effecting in the depletion of agricultural labour force of rural area.

In country like India and the progressive state of Maharashtra where agriculture sector contributes major share of their income, will have great impact on the increase/decrease of per capita income, and therefore agriculture continues to play an important role in raising the living standard of the people. Analytical studies related to agricultural growth would provide valuable information for future planning and projections of

agricultural output. There are many factors such as introduction of high yielding varieties of seeds, increasing irrigation facilities, better application of fertilizers and manures, better prices and market facilities for agricultural commodities leads to promote agricultural development. The adoption of cropping pattern optimally suited to the technological changes is also an important factor for augmenting growth of agriculture.

The rural economy of Vidarbha is basically a crop economy. Through contribution of other sub sector like horticulture, forestry as increase overtime, the cropping sector remains the major contributor to the domestic product. With the development of agriculture, cropping pattern has been changed to cope with the changing scenario and to meet the ever-changing demands of growing population. Limited supply of land along with increasing population and declining yield compelled the farmer to search for alternative been made to analyze the behavior of cropping pattern for last 10 year, in Wardha district of Nagpur division.

1.2 Importance of the study

The study of cropping pattern assumes a great significance as it is one of the important path for balanced development of agriculture to meet the requirements. The adoption of better cropping pattern optimally suited to the technical changes is an important one for augmenting agricultural growth. Cropping pattern of a particular area either state region, districts, etc. emerges through the interaction of physical, social, economic, technological and infrastructural factors. It is a function of climatic elements, their periodicity expressed in terms of seasons, nature of soils, physiographic and man introduced factors like irrigation, fertilizers, etc. amongst the climatic factors, precipitation, its distribution and periodicity has a greater determinant value. The impact of each of these factors would differ depending upon the prevailing situation of a place. Cropping pattern indicates the percentage of area occupied by different crops. The variation in cropping pattern is also influenced by economic conditions and behavior of farmers who decide the type of crops to be grown. Farmer might choose such crop combination which will be best suited to his field under the given conditions. Change in cropping pattern

would be an integral part and popular mode of diversification and resource mobilization available to cultivators for higher agricultural production.

Cropping has been dynamic to cope up the changing scenario and to meet ever changing demand of growing population. Limited availability of land rising population and declining yields, forced farmer to search for alternate ways for raising farm income, with the passage of time farms becomes increasingly commercialized and started farming for maximizing their output. Now the realization prevails amongst the farmers for the long term returns, and they are in search of optimum cropping pattern which can fulfill their aspirations. It is also found that the higher the technical inputs, lesser the degree of diversification.

In present scenario developmental paradigm of agrarian economy specifically in case of developing country like India, diversification concept applied to individual farmers and to different farms as well as to study regions. In the third world country like India where man-land ratio is higher enough, agricultural diversification especially in terms of crop diversification is very much necessary (Let, 2011). At the same time, Indian agriculture is gamble in monsoon i.e., to get rid from helpless dependency on seasonal monsoonal rainfall, irrigation facilities-one of the most efficient infrastructure technological aids are earnestly required so that agricultural economy is established in the strong relative platforms (Let Bhattacharya,2010). In this context, the study of crop diversification is very much important due to following reasons (Hussain, 2009):

1. In the monsoonal country (e.g., India, Bangladesh), where whole agriculture system mainly depends on monsoon-rain; farmers often prefer to plough different crops in different seasons because of variability of rainfall and inadequacy of source of irrigation.
2. In the tradition bound subsistent farming systems, the farmers grow several crops to meet the family requirements. In such areas, one may find a high degree of crop diversification.

3. Diversification has usually been done by the farmers to enhance nitrogen in the soil and to replenish the soil fertility. Crop diversification increases the sustainability of arable soil.
4. The diversification of crops also generates more employment as the farmers and agricultural workers remain busy in the sowing, weeding, harvesting and marketing of different crop throughout the year. Diversification of crops also enables the farmers to provide a reasonable quantity of the costly inputs to their crops as different crops need different quantities of inputs (e.g., chemical fertilizers, insecticides, pesticides and irrigation).

In fact, it is obvious that greater the number of crops in combination, greater will be the degree of diversification. The main advantage of the study of crop diversification region lies in the fact that it enables to understand that impact of physical and socio economic conditions on the agricultural mosaic. Moreover, it help to know the contemporary competition among the crops for an area and scope for rotation and effect on double cropping, total production and per hectare productivity. Keeping in this view in mind, the present study entitled, “Structural Changes in Cropping Pattern in Selected Tahsils of Wardha district”.

1.3 Objectives

1. To study the changes in cropping pattern in selected tahsils of Wardha District.
2. To estimate the growth and instability in area of major crops in selected tahsils.
3. To study the crop diversification in selected tahsils.
4. To study the structural changes of cropping pattern in selected tahsils.
5. To identify the advantageous crop in selected tahsils.

1.4 HYPOTHESIS

1. Cropping pattern changes over the period of time in selected tahsils of Wardha District.
2. Crop diversification is occurred in selected tahsils of Wardha District.

1.5 Scope

The study of changes in cropping pattern will help farmers to use the better availability of microclimate, inputs and changing scenario of market condition. Study of crop diversification also help the policy makers to work according to changing trend. Economics of various crops gives idea about their profitability which would help the farmers for allocation of scarce resources.

CHAPTER II

REVIEW OF LITERATURE

Review of literature gives the guidelines from the past researchers and provides foundation to the theoretical frame work for the present investigation. The review of past literature makes the investigator to get an insight in to the methods and procedures to be followed. This chapter deals with review of concepts used in the study as viewed by different authors and review of related studies in the past. Several studies have been carried out in the recent years to show the changes in behaviour of cropping pattern in various states of India. The available literature relevant to the objectives of the present study was reviewed and presented in this chapter under the following headings.

2.1 Changes in cropping pattern

2.2 Growth and instability

2.3 Crop diversification

2.4 Structural changes of cropping pattern

2.5 Advantageous crops

2.1 Changes in cropping pattern

Kebede et al. (2000) studied the diversification of agriculture in Haryana. Study revealed that cereals, commercial crop, vegetables and fruits were found to be relatively towards diversified as compared to pulses and oilseeds among the crops groups. Diversification towards high-tech innovative enterprises within the agriculture sector has been gaining momentum in the state.

Hazra (2001) studied the changes in cropping pattern at the all India level by considering the area share of crops and crop groups at four time points, respectively the triennium ending average of areas at 1966-1967, 1976-1977, 1986-1987. The study revealed that there was a shift from traditionally grown less remunerative crops to more remunerative crops. The crop shift took place due to government policies and thrust on

some crops in a given time. Market infrastructure development and certain other price related support also induced the changes in cropping pattern.

Jayakumar and Velayudham (2002) studied the agricultural stagnation in Kerala and reported that agriculture, though stagnant for the last many years, was still a major sector of Kerala economy. They observed that the area and production of food crops had been declining over the years, while the area, production and productivity of cash crops had increased. They concluded that the prevalence of obsolete technology in the state and the relative profitability influenced the farmers' decision to allocate land under different crops and resulted in agricultural stagnation.

Virander kumar et al. (2002) examined the changing cropping pattern in Himachal Pradesh. He reported that total cropped area increased by about 21 thousand hectares from 16.69 per cent to 17.06 per cent of the total geographical area during the period 1972-96. The area under wheat, as per cent of total cropped area, increased from 34.27 per cent to 37.66 per cent and that of maize went up from 28.11 per cent to 32.58 per cent. The magnitude of decline in percentage share in area in ragi and other millets was much higher than that of barley.

Kumar and Mittal (2003) examined changes in cropping pattern (crop diversification) that took place in various states of India in three decades during 1970's, 1980's, and 1990's and measures the aggregate changes in cropping pattern in terms of substitution and expansion effects. They also examined the degree of crop diversification in various farm size groups. They concluded that the changes in cropping pattern have been taking place as a result of substitution from low productivity crops to high productivity crops, some of these crops are paddy, wheat, maize, groundnut, rapeseed, mustard and sugarcane. Coarse cereals and pulses have shown a study decline in the area. Regional pattern in crop specialization is increasing. They have stated that the small farms practiced multi-diversified farming and grow a number of crops even on fragmented plots, involving allocation of area under seasonal fruits, vegetables, etc. for maximizing their household income and employment in almost all regions of the country.

Goswami et al. (2003) in their attempt to study the change in cropping pattern in Mizoram noticed maximum growth rate in pulses (13.82 percent) followed by tapioca (9.46 percent). Area under sugarcane and cotton was showing a significant positive growth rate of 2.56 per cent.

Goswami and Challa (2004) studied the changes in cropping pattern for the period 1951 to 1998. The results showed that there was gradual shift in area from food crops to non-food crops indicating more diversification in recent times. The proportion of area under total cropped area reduced from 61.1 per cent in 1950-51 to 53.08 per cent in 1997-98. Reverse scenario was noticed in the case of total oilseeds where there was almost three-folds increase in area during the period under study.

Alagh (2007) studied the growth and changes of Indian agriculture since the eighties. The study revealed that agricultural sector was traditionally regarded as having low price responses. Cropping patterns were different in different area because of economic reasons or technological reasons but the change was slower.

Dinesh et al. (2007) studied the crop diversification in Chhattisgarh and observed that the pattern of land use and cropping pattern has changed during pre-reform, reform and post reform periods. The area under forest had increased in Chattisgarh plains and Northern hills, while it has decreased in Bastar plateau. Land put to non-agriculture uses and cultivable waste land had increased in Chattisgarh plains while it has depleting very fast. On the other hand, paddy area has been continuously increasing in last three decades. The increase was occurred at the expense of coarse cereals and minor millets area. Wheat area was diverted to gram in post rainy season.

Tingre et al. (2007) studied growth rate and cropping patter changes in Amravati division of Vidarbha. They observed that growth rate of major cereals is declined and that of pulses is increased over a period of study. Crop diversification and cropping intensity were significantly increased in Amravati districts.

Batla (2008) studied the regional dimensions of inter-crop diversification in India and observed that inter-crop area shifted in favour of

high yielding crops like wheat, paddy, oilseeds, cotton and sugarcane, up to eighties and towards paddy, sugarcane, fruits-vegetables, fibers, plantations, condiments and spices during the nineties and early 2002. The area under wheat and paddy had expanded solely at the cost of low yield growth crops like coarse cereals and pulses due to price support and HYV programme. The high value commercial crops have benefited both from area shifts as well as fresh land brought under cultivation.

Tingre et al. (2008) studied the cropping pattern changes and crop diversification in Akola district of Vidarbha. The study revealed that majority of cereal crops showed negative and low growth rates of area during the study period. Soybean had attained important position in the cropping pattern. The trend of crop diversification and cropping intensity increased significantly.

Meenakshi and Indumathy (2009) studied the land utilization and cropping pattern in Tamil Nadu. The study revealed that there was a considerable reduction in cultivated area and hence output was affected to a great extent. The cropping pattern in the state had a high degree for maladjustment for the crops. Roughly 53 per cent of the cultivated area was being used for growing unsuitable crops.

Tingre et al. (2011) studied the cropping pattern changes and crop diversification in Wardha district of Maharashtra. The study was based on secondary data collected from different Government publications for a period of 32 years *i.e.* 1970-71 to 2001-02. The study has examined the growth rates of area, production and yield of major crops, changes in cropping pattern and the trend in crop diversification and cropping intensity in Wardha district of Vidarbha. The compound growth rates of area, production and yield of major crops were estimated for two sub-periods *viz*., period I (1970-71 to 1985-86) and period II (1986-87 to 2001-02). The results showed that in Wardha district the area growth rates declined significantly for rice (-2.99 per cent), bajra (-5.64 per cent) and other crops were stagnant during period I. Whereas the growth rates of production declined significantly with respect to rice (-16.97 per cent) and bajra (-6.74 per cent). Except soybean, the yield growth rates of all the crops were

stagnant during period II. In the cropping pattern dominating crops were cotton (32.72%), soybean (31.55%), pigeonpea (12.10%) and Kharif jowar (10.04%) constitute the major portion of cropping pattern (86.41 per cent). During the study period, the trend of crop diversification and cropping intensity increased significantly.

Ahmad Fahim Rahimi (2012) analyzed the changes in cropping pattern in Karnataka. The necessary secondary data was collected for a period of 30 years from 1979-80 to 2008-09. Tabular analysis, Growth rate, Concordance analysis and Multiple linear regression analysis were employed to analyze various aspects of the changes in cropping pattern. Plantation, condiments and spices, fruits and vegetables occupied a considerable share in gross cropped area over the periods. Barring cereals and minor millets and commercial crops most of the crops categories registered a positive annual growth rate in area during the study period. Area under soybean, maize, bengal gram, paddy, sugarcane, onion, and green gram has increased over the year while that of the jowar, horse gram, linseed, safflower, sweet potato and coriander has considerably declined in state. Kharif crops occupied considerable area in all the districts. Net cropped area showed decreasing trend while cropping intensity has increased in the state and in all the districts. The concordance coefficients revealed that the area share of crops in the study period were not in agreement with each other. Multiple regression analysis revealed that net and gross irrigated area, area under high yielding varieties, annual rainfall and land holdings were the factors responsible for the changes in cropping pattern.

Sheeba Andrews (2013) studied the dynamics of cropping pattern shifts in Kerala : sources and determinants and reported that the dynamics of crop shift from food to non-food/commercial crops and the reasons behind the shift mainly took place after the land reform measures. Thus, the underlying forces behind the crop shift has been identified as the government measures starting with land and labour policies and other institutional measures thereafter to support commercial oriented production. This has been analyzed through decomposition analysis and

has been found that the area effect has been contributing more for increasing production of commercial crops and decreasing production of food crops such as rice, tapioca and pulses. The large scale conversion of paddy land to coconut and rubber needs to be checked as the wetlands are getting destroyed in Kerala.

Kamalika Majumder (2014) examined the Nature and Pattern of Crop Diversification in West Bengal with respect to acreage and production distribution. The study revealed that from both the aspects of area and production over the time span of three decades the cropping pattern in West Bengal is increasingly dominated by boro paddy, oilseeds (including, rapeseed and mustard) and potato. Pulses, as a whole, have lost both in terms of acreage and production in West Bengal. The indices of diversification mostly indicate an increasing degree of crop diversification over time. These crops are either HYV or cash crops and hence are more remunerative over other crops. The oilseeds have another advantage. Besides being remunerative, they also require less irrigation which makes them ideal for cultivation in the areas with less rain or irrigation.

Chinky Sangral (April 2015) examined Changes in Cropping Pattern and Crop Diversification in Jammu and Kashmir. The study revealed that the area under vegetables and fruits increased at the cost of other food crops which showed a decreasing trend during the study period. A trend of shift from food grains to non food grains has been observed by the process of development which indicates an increasing tendency towards crop diversification. Within crop groups like cereals, there is an increase in the area under wheat and maize, whereas area under rice has been fluctuated. The area under other cereals had decline. Due to the increase in demand for fodder to feed the poultry, the area under fodder has shown an increase and a favourable price policy has resulted in an increase in area under wheat. The cereal crop shown a higher growth, non cereal crops and allied farm activities also recorded improved performance. Even though with the introduction of cropping pattern in the state, production of both food grains and non food grains have tremendously

increases but comparatively production of food grains and non food grains had not been increased proportionately.

Dinesh Kumar Nayak (2015) studied changing cropping pattern, agricultural diversification and productivity in Odisha for a period of 1980-85 to 2009-10. The study revealed that there was changing trend of the cropping pattern in Odisha in recent years. The area under rice was increased from 48.1 per cent of the gross cropped area of the state in 1980-85 to 55.6 per cent during 2000-2005. The temporal changes in cropping pattern in Odisha revealed that crop diversification took place in the state. During the period 1980-2005, the area under some cereals (wheat, ragi, jowar, bajra, small millets), rabi pulses; oilseeds (castor, linseeds and safflower); and cash crop (jute, mesta, tobacco) declined by varying degrees and increased under selected cereals (rice and maize); oilseed crop sunflower; cash crop cotton; and condiment and spice crop ginger. There was a marginal increase in the area under cash crops.

Rubeenah Akhter and Dr. Rekha Acharya (2015) examined the changes in cropping pattern in Jammu and Kashmir for the period of 2005-06 to 2012-13. The study revealed that the area under fruits and vegetables was steadly increase from 8.15 per cent in 2005-06 to 10.14 per cent in 2012-13. There was an increase in the area under wheat, whereas area under rice and maize was fluctuated. Price related factors covering output and input prices as well as trade policies and other economic policies influenced the cropping pattern of area.

Shelar Suresh Kautik and Raut Vinod Ramdas (January 2015) analyzed the agricultural land use pattern in Nashik District. The study is based on secondary source of data obtained from the district statistical handbook. The study concluded that among the cereals, Bajara and Rice rank first and second respectively. Vegetable, Grapes are major cash crops of the district. The study of ranking indicated that the farmers of Nashik District prefer food crops firstly and then they cultivate Grapes and vegetable cash crops to fulfill their economic needs due to the lower development of irrigation facilities. The study of crop combination revealed

that monoculture is totally absent in the Nashik District and indicated that the lower development of technological factors and irrigation facility.

2.2 Growth and instability of major crops

Mitra (1990) made an attempt to examine the growth of agricultural production in Maharashtra and its four regions for the period 1956-57 to 1984-85. The entire period of the study has been divided into two sub periods for estimation of the growth rates of area, production and yield of major crops. The author stated that annual compound rate of growth of agricultural production in the state as well as in all the regions specially that of food grains was relatively higher in twelve year period ending 1984-85, after a near stagnancy in sixteen year period ending 1971-72. The overall rate for the growth of production of food grain was around 2 per cent per annum which has been mainly brought about by growth in yield. Amongst cereals the rate of growth in yield of wheat is not of much higher order than those of other cereals. Jowar, pulses also show a very overall rate of growth in production brought about by equally marginal rate of growth in area and yield. Comparatively Nagpur region showed a better performance mainly because of good performance under jowar. Groundnut and cotton did not show any significant overall growth in production. The overall growth of area under these two crops was negative and there was marginal increase in the rate of growth of yield for these crops.

Mundinamani et al. (1995) examined the growth performance of groundnut, sunflower, safflower and sesamum for the selected districts of Karnataka and the state as a whole. The study was conducted for the period from 1955-56 to 1989-90. Growth rates were computed for two sub-periods namely pre-green revolution period (1955-56 to1989-9). They have fitted the exponential function i.e., $Y_t = a.b^t$ for the analysis. The results of the study showed that the growth in production was achieved mainly due to expansion of acreage in the study area and to some extent by yield effect in the recent years the improvement in yields was observed in areas where irrigation facilities were extended. They have stated that the potentiality of

the viable technology developed for major oilseeds was not yet made a significant impact in increasing oilseeds productivity.

Shete et al. (1997) analyzed the nature of growth of agriculture among the four regions of Maharashtra viz. Western Maharashtra, Konkan, Marathwada and Vidarbha for the period from 1956-57 to 1989-90. They have estimated compound growth rates of area, production and productivity of total cereals, pulses, oilseeds, sugarcane and cotton during period I) (1950-57 to 1989-90), period II) (1967-68 to 1977-78), period III) (1978-79 to 1989-90) and the entire period of 34 years i.e., 1956-57 to 1989-90. The study revealed that performance of agriculture in Maharashtra was mixed type among different regions. The increase in the production at cereals during period I was due to area expansion while the productivity was declined. In oilseed Maharashtra continued to be a deficit state during the sixties and seventies. The result showed that aggregate output depended largely on the magnitude of cropping intensity.

Balappa et al. (1999) attempted to analyze the growth performance of red gram in Gulbarga district and Karnataka state as a whole over the period 1980 to 1994. The quadratic growth function was fitted for the estimation of growth rate in area and cubic function for production and productivity. The study showed that area under red gram declined significantly by 10 per cent and 9 per cent per annum respectively during 1980-81 to 1994-95 in Gulbarga district and Karnataka state as a whole. The analysis concluded that even though the area had declined significantly, the production did not decline to the significant increase in its productivity for the state as a whole.

Legesse (2000) found that during eighties wheat area showed a declining growth rate i.e., 3.94 per cent per annum but production and productivity showed a negative growth rate. During nineties the Karnataka state recorded a positive growth rate of 3.47 per cent in area while in production the state recorded a mild growth, productivity showed a negative growth rate.

Navadkar (2003) revealed that the area, production and productivity of cotton in India during 2001-02 were increased by 48.81, 2271.71 and 150 per cent change over 1950-51. It means that the production increased rapidly than once due to increased productivity by 2.5 times over 1950-51.

Marawar et al. (2004) examined the performance of oilseed in different district of Vidarbha for the period from 1980-81 to 2001-2002. The study revealed that area of Kharif groundnut decreased over the period of study in Vidarbha, whereas summer groundnut showed mixed trends. The area under sunflower and soybean was increased significantly in all the districts of Vidarbha. In general the area under total oilseeds was increased significantly. The production of Kharif groundnut decreased over the years of study but the production at sunflower, summer groundnut, safflower and soybean increased significantly. The productivity of Kharif groundnut and soybean was increased. Sunflower was more or less stagnant over the study period during the study period the productivity at safflower increased at a growth rate of 1.80 per cent in Vidarbha.

Shende et al (2010) studied growth and instability of selected crops in Western Vidardha for a period I (1984-84 to 1994-95), period II (1995-96 to 2006-07) and overall period III (1984-85 to 2006-07). The study revealed that the compound growth rates for area and production of jowar were recorded near about equal which may be due to compound growth rates of productivity. The growth rate for area and production for soybean was recorded very high during period I, which may be due to introduction of soybean in the year of period I. The coefficient of variation and coppock's instability index with regards to both area (8.43 and 10.47 per cent) and productivity (20.29 and 12.40 per cent) were lowest in Yavatmal district among jowar growing districts of Amravati division. Coefficient of variation and instability for area, production and productivity were high for soybean as compared to jowar and cotton at overall period. At overall period, the area effect was most stronger factor for increasing production of jowar in all the districts and divisions as a whole, except Akola district i.e. 305.22 per cent. At overall period, the results clearly

indicated that the yield effect was most responsible for production of cotton in all the districts of Amravati division as a whole and the area effect was most responsible factor for increasing soybean production in Amravati division i.e. 46.98 per cent with positive yield and interaction effect 1.91 and 51.41 per cent, respectively.

Deepak K. Ray et al. (2012) analyzed recent patterns of crop yield growth and stagnation with the Global yield trends. They found that global yield trends can be broadly divided into four types. First, 'yields never improved' areas that have witnessed no significant yield improvements to date. Second, 'yields stagnated' areas where yields previously improved, but now are stagnating or declining. This category includes a range of yield trends post a year of yield maximum, including yields hovering near the yield maximum (that is, a yield plateau) and yield declines at various rates. Third, 'yields collapsed' areas where yields decreased since the 1960s, or initially increased and then collapsed to the 1960s level. Fourth, 'yields still increasing' areas where yields are still increasing. Overall, their analysis showed that most of the world has historically experienced significant yield improvements. The percentage of the world never experienced maize, rice, wheat or soybean yield improvement is small. They found that the world's maize, rice, wheat and soybean crops are continuing to experience yield increases in over 70%, 63%, 61% and 76% of their harvested areas, respectively corresponding to 103, 96, 130 and 63 million hectares (m. ha). Globally, however, rice (35%) and wheat (37%) have substantial areas that are now witnessing yield stagnation. Maize (26%) and soybean (23%) have less area in yield stagnation. Furthermore, they also found that 3% of maize, 1% rice and 1% of wheat areas have experienced yield collapse. Areas where yields are still increasing currently contribute roughly 79%, 57%, 56% and 82% of the total global production in maize, rice, wheat and soybean, respectively. This then means that for wheat and rice, at least, yield stagnation may have profound implications on the ability of agriculture to meet the growing global demands for these commodities.

Firdos Ahmad MD and Shaukat Haseen (2012) studied the Performance of India's Food Grains Production: A Pre and Post Reform Assessment from 1970-71 to 1990-91 and second from 1991-92 to 2008-09. Six parameters are taken into consideration for the analysis. These parameters are total food grains productions, area under cultivation, yield per hectare, consumption of fertilizers, area under irrigation and rain fall. The study revealed that, there is significant decline in growth of production and productivity of total food grain production in post reform period. However the growth of coarse cereal and pulses in post reform period has increased. But most heated items of food grain are rice and wheat whose growth of production and productivity adversely affected in post reform period. The adverse effect on production and productivity of rice and wheat is not only reduction on subsidiary on agricultural inputs but also the overall declined in amounts of rain fall and shifts in the timing of the rain fall. Any change in rain fall patterns poses a serious threat to agriculture and therefore to the economy and food security.

Ramphul (2012) studied the Performance and Suitability of Growing Crops in Haryana: District-level Analysis. The cropping pattern and performance of different districts in growing different crops in Haryana are assessed using three standards measures, namely) (i) location quotient, (ii) crop versatility index, and (iii) district versatility index over the period 1991-92 to 2008-09. The specialization of maize in Ambala and Yamunanagar, cotton in Hisar, sugarcane in Yamunanagar and Ambala, mustard in Rewari and Mahendragarh, gram in Mahendragarh, bajra in Rewari are the highest during the study period with the value of location quotients to be more than two. The specialization of wheat in Panipat, Hisar and Fridabad, rice in Kurukshetra, Kathal and Karnal, jowar in Rohtak and Faridabad is highest during the period of study. The highest specialization of bajra is observed in Mahendragarh, Rewari and Gurgaon. The increase in value of versatility indices for majority of districts during 2000-01 to 2008-09 as compared to 1991-92 to 1999-2000 implies the move towards specialization. It is established that maize, gram and cotton are highly localized crops.

Solmon R. Paul et al. (2012) examined the growth and variability of groundnut crop in Andhra Pradesh over a period of 1995-96 to 2010-11. The study analyzed that area, production and productivity was decreased during the study period. The compound growth rates of area, production and productivity of groundnut over the period showed negatively non-significant. The synchronized movement in area and productivity both was responsible for low instability/variability in groundnut of Andhra Pradesh. The study conducted a decomposition analysis to determine the contribution of different components to the growth rate. The decomposition analysis revealed that the total production of groundnut was completely due to change in area under the crop as the yield and interaction effects were very small. The percentage change over the period for area, production and productivity of groundnut in Andhra Pradesh had a negative values except 7 years i.e. 1998-99, 2000-01, 2003-04, 2004-05, 2005-06, 2007-08 and 2010-11. Area, production and productivity of groundnut in Andhra Pradesh showed negative trends of 0.019, 0.036 and 0.017 per cent per annum respectively over the study period. It was observed that the production of groundnut recorded the highest degree of instability.

Amarender Reddy.A (2013) Agricultural productivity growth in Orissa, India: Crop diversification to pulses, oilseeds and other high value crops. Inter-state comparison of agricultural sector with special emphasis on Orissa is done from 1971 to 2008 by using data from statistical abstracts of various states .Out of the Gross Cropped Area (GCA) of 9.0 mha in 2008, 77% is under food grains. Thus, only 23% of the GCA was under non-food grains, which includes oilseeds, fibre crops, and HVCs. Paddy occupies about 50% of GCA, followed by pulses (22%), oilseeds (9%) and HVCs (13%). Area under paddy decreased from 66% in 1971 to 46% in 1991, then again increased to 50% by 2008, while area under oilseeds increased from 4.9% in 1971 to 12% in 1991, then declined to 9%, and pulses area increased from 12.5% in 1971 to 22% in 2008. Area under HVCs increased from 8.1% in 1971 to 13% of GCA in 2008. Cropping intensity increased from 133 % in 1971 to 158% in 2008. Over all, food grain production increased from 5.6 million tons (mt) during triennium

ending average (TE) 1973 to 7.4 mt in TE 2008, entirely contributed by increase in paddy production from 4.2 mt in TE 1973 to 6.0 mt in TE 2008. Pulses production stagnant at 0.8 mt and oilseed production is also stagnant at about 0.5 to 0.6 mt. This indicated the dominance and increased importance of paddy in the state. However, productivity of paddy still low, increased slowly from 964 kg/ha to 1335 kg/ha in Orissa, whereas it increased from 1312 kg/ha in period-I to 1940 kg/ha in Period-II for all India. Productivity of pulses declined (from 503 kg/ha to 441 kg/ha) and oilseeds stagnant (from 683 kg/ha to 669 kg/ha) between two periods. The productivity of all major crops was lower in Orissa than all India in both the periods. During Period-I, growth in production of food grains is lower in Orissa compared to all India, while growth in pulses and oilseeds is higher. During Period-II, the growth rates for all the crops (food grains; including paddy, pulses and oilseeds) in production, area and productivity are lower (and reduced) in Orissa than all India. This shows the decline or stagnation in Orissa agricultural sector during both the periods, but it is alarming during recent period. The over emphasis on paddy at the cost of pulses, oilseeds and other HVCs resulted in stagnation in productivity of the later crops during period-II.

Kirtti Ranjan Paltasingh and Phanindra Goyari (2013) analyzed growth and instability in subsistence agriculture of Odisha for a period of 41 years, from 1970 to 2010. Studies showed that agriculture in Odisha was experiencing high concentration of crop towards rice. Thus there was diversion of cultivable areas meant for other crops, towards rice. The area under rice maintained a positive growth, though trivial because of only diversion of area from other crops. The analysis of growth rate of production showed that some crops like wheat, ragi and millet experienced decline in the pre-liberalization period, which exacerbated in the post-liberalization period. Other crops like bajra, jowar, gram, arhar, experienced a deceleration in post-reform period compared to pre-reform period. The rice and maize maintained a positive growth trend in both the periods with maize experiencing acceleration, though not much. It revealed that rice was the only crop benefitted from the reforms. Somehow maize

was also benefitted though its area was declining. The study shown increase in stability in the post reform period. The cropping pattern was highly skewed towards rice and crop diversification is very low.

Soumitra Chatterjee et al. (2013) evaluated the temporal analysis of district wise agricultural crop performance scenario in West Bengal, India: They attempted to evaluate district wise growth in acreage, production of major crops grown in the state of West Bengal, India over last three decades (1980-81 to 2011-12) as well as to measure the crop wise level of instability in area and production. Also a comparative study on relative performance of districts in terms of individual crop and aggregation of major crops grown in the state has been performed subsequently, to identify the district wise overall crop-performance scenario for the past three decades. They concluded that there is a subsequent contraction in area under *aus* cultivation in West Bengal with the progress of time. *Aman* is still considered as the major rice grown in predominant rice belt of Bengal features stagnancy in acreage and production over time. *Boro* has gained an immense expansion in acreage in the first decade however fails to retain its pace and started declining in the later phases under study. Wheat area has been subsequently diminished over the year in almost all the districts of the state where jute has still been cultivated in the major jute belt of southern and northern part of Bengal. Potato growth has been spectacular in the first decade in Burdwan and Hooghly while reducing at later phases under study. Mustard has been grown in the traditional belt of Bengal (24-Parganas, Nadia and Murshidabad) while its area started declining as the period progresses. Overall crop performance scenario has featured that progressive districts in terms of agricultural development under gangetic alluvium tract of West Bengal have shown higher crop performance over the period under study. This might be due to improved fertility status of soil with a large number of progressive growers operating in terms of a better knowledge gaining, a better education and extension.

Kadli Vinayaka et al. (2014) analyzed the growth and instability of fruit crops in India from 2000-01 to 2010-11. In India growth rate of fruit crops productivity was positive (1.05 per cent) and was

associated with instability index of 10.16 per cent. In the same period positive growth of area was observed (7.34 per cent), while a positive growth rate of production was 8.48 per cent with instability index of 0.10 per cent.

Narendra singh et al. (2014) studied the growth and instability in rice production in Gujarat by decomposition analysis during 1982-83 to 2011-12. It was observed that there was slight change in area under rice cultivation in Gujarat state. During study period there was slight increase in area by 0.41 per cent per annum. Production and productivity of rice shown positive growth during the study period. Among the selected districts growth in area was between 0.91 to 2.76 per cent per annum. Highest growth in production was observed in Ahmedabad district. The coefficient of variation for production of rice in the state of Gujarat was 20.50 per cent during study period. For the selected districts, the coefficient of variation varied from 28 to 70 per cent during the study period. The coefficient of variation for rice productivity of the state revealed 16.75 per cent. Among the districts, coefficient of variation for productivity varied from 14 to 60 per cent during the study period. The extent of variability was higher for the districts compared to the state. The variability in all the three variables i. e. production, area and productivity was higher in the districts compared to the state as a whole. The destabilizing effect on production was more compared to area and productivity.

Rakesh Sihmar (2014) examined the growth and instability in agricultural production in Haryana and observed that the growth rate of agricultural production shown changes in spatial pattern of different crop. On the one hand some crops like rice and wheat show a very satisfactory performance in their production in all the three periods (1980-81 to 1989-90, 1990-91 to 1999-2000 and 2000-01 to 2006-07). On the other hand, crop like gram, masser, maize, sesamum, groundnut, showed unsatisfactory performances in their production. All these crops registered negative growth rate in production over the periods. In the case of total pulses, the production shows a declining trend over the periods. Gram showed highest declining trend over the periods in both, production and

area. Mung registered negative growth rate during 1980's and 1990's while it showed positive growth rate during 2006-07. The production of cotton registered positive growth rates over the periods. The instability was low and also declined over the time in wheat and rice and there was clear evidence of crop diversification towards rice, wheat, cotton and other crops. The instability in wheat, rice and sugarcane was low, while in gram, mung, massar, it was high in all the periods. The result show that the trend of instability was still high in many crops like gram, mung, massar. Instabiltity in jowar was declined sharply from 1980-81 to 2006-07. During eighties jowar production declined due to crop diversification however being an animal feed it could not be ignored. That was why the production of jowar increased later and with this effect the instability declined and it become low instability crops during 2000-01 to 2006-07. On the other hand, the instability was high in pulses and coarse cereals because area under these crops was shifted towards rice and wheat and increased the instability in the production of these crops.

Saleem Abid et al. (2014) analyzed the Growth and Trend in Area, Production and Yield of Major Crops of Khyber Pakhtunkhwa, Pakistan from 1980-81 to 2011-12 (32 years) of major crops (wheat, maize, rice and sugarcane). The compound growth rate as well as trend analysis indicated that the area under wheat crop has decreased over the time due to shifting of area to other rabi crops. The production of wheat during 1981-85 to 2010-12 was increased due the corresponding increase in per hectare yield of wheat crop in Khyber Pakhtunkhwa. The results showed that area, production and yield of maize was increased over the time the reason is that more area was brought under hybrid and improved open pollinated maize varieties. The area under rice crop has decreased whereas their production increased due the corresponding increase in per hectare yield of rice crop. It was revealed from the results that area, production and yield of sugarcane crop was increasing at a rate of 0.24 percent, 0.85 percent and 0.60 percent per annum, respectively.

Boyal et al. (2015) examined growth and instability in area, production and productivity of fenugreek in Rajasthan for the period I

(1991-92 to 2000-01), period II (2001-02 to 2010-11) and overall period (1991-92 to 2010-11). Growth rates of area and production in fenugreek was observed positive and significant in Kota and Jhunjhunu districts of period I and overall period. Growth rates of production in fenugreek was found negative in Sikar district during period I and in Kota and Sikar districts during period II due to negative growth in area of fenugreek. Growth rate of productivity in fenugreek was recorded positive and significant only in Kota district during all three periods. Production of fenugreek increased significantly in Kota (64.50%) and Jhunjhunu (36.22%) district, which was due to positive and significant growth in area by 54.09% and 41.18% per annum, respectively. Negative growth rates in production of fenugreek was observed in Sikar district (-8.53%) during period I due to negative growth in area by -13.38% per annum. During the period II, in Sikar district (-7.55%), Kota district (-3.29%) and in Rajasthan state (-0.01%) showed negative growth rates in fenugreek production. It was observed that there was highest instability in area in Kota district. Lowest instability with respect to area found in Sikar district. The instability in area under a crop is mainly governed by the profitability of the competing crops grown in that area. In Kota district highest production instability was observed. Sikar district shown low instability with 56.10 per cent in context of area and Jhunjhunu district shown low instability with 52.58 per cent and 37.39 per cent with respect to production and productivity respectively.

Nijan Chandra Pegu and Dr. Chandan Hazarika (2016) examined the growth and instability in area, production and productivity of rice crop in Assam. The study was conducted for the period of 20 years which was further divided as Period I (from 1991-92 to 2000-01), period II (from 2001-02 to 2011-12) and pooled period (from 1991-92 to 2011-12). Study revealed that in Assam, growth rate in area registered a positive and significant under winter rice and growth rate in area under autumn rice found only positive without any significant in period I. In the same period, it was found that the growth rate in yield under summer rice shown negative and the growth rate in yield under winter and autumn rice shown positive without any significance. In production growth rate, it was found that the

winter and autumn rice registered positive and summer rice registered negative growth rate. During period II, the highest recorded growth rate in area was under summer rice followed by autumn and winter rice. The pooled period also indicated highest positive growth rate in area under summer rice followed by winter and autumn rice. It was seen that the growth rate under summer rice is highest in area, production and productivity than the winter and autumn rice in Assam. It was found that area in summer rice shown highest instability followed by autumn and winter rice respectively. Area in autumn rice shown the highest instability followed by summer and winter rice in period II. In the pooled period, it was found that the instability in area under summer rice shown highest followed by autumn and winter rice respectively. Instability in yield during period I and pooled period highest in summer rice. During period II, yield instability was highest in autumn rice and lowest in summer rice.

2.3 Crop diversification

Utpal Kumar De (2000) examined the levels of crop diversification in different districts of West Bengal during 1970-71 to 1994-95. Triennia average of area under crops has been calculated for the periods of area under crops has been calculated for the periods 1970-73, 1977-80, 1984-87, and 1991-94. The different crops diversification indices have been calculated from triennia average data to know the level of concentration at different points of time and their change over the year. The author concluded that there exists wide spatio temporal variations in the acreage allocation under different crops. In general there has been a movement towards more commercial crops. The author suggested that the study of crop diversification may be utilized to find out its contribution to the changing income and also to examine its long term impact on the resource base viz., productivity of land, use of other resources, etc.

Joshi et al. (2004) studied the status of Agricultural diversification in South Asian countries for a period of two decades from 1980-81 to 1999-2000. For assessing the extent of diversity in crop, livestock and fisheries activities, they used Simpson index. The results of

the study revealed that agricultural sector in South Asia is gradually diversifying in favour of high value commodities namely fruits, vegetables, livestock and fish products. Much of the diversification came, if at all, with only little support from the governments. Despite fousing effects towards food grain production in South Asian countries, a silent revolution is witnessed in high-value commodities. The author reported that production of fruits, vegetables, livestock and fish products have increased remarkably in most of the South Asian countries. During 1980's production increase was attributed to the rise in their yield levels. During 1990's production increase came from area augmentation. In Indian context the key determinants for high value commodities (Horticultural and Livestock) were markets and roads and were influencing the status of diversification other important determinant was the technology absorption in the region. Higher the technology adopting of cereals (Particularly irrigation) less was the diversification in favour of high value commodities. Diversification in favour of horticultural and livestock commodities was more pronounced in rainfed areas which was passed during the green revolution but now could take advantage of agricultural diversification. The rainfed areas were becoming a hub of non cereals due to their low water requirement and abundant labour supply. Besides, relative profitability of high value commodities in relation to other crops also played important role in determining status of diversification.

Ruma Bhattacharyya (2008) studied the crop diversification: a search for an alternative income of the farmers in the state of West Bengal. The results of the study showed that agricultural sector of West Bengal is gradually diversifying towards high value commodities, namely fruits and vegetables and flowers. Detail investigations revealed that most of the diversification has come through individual efforts of the small farms with little support from the government. A silent revolution is taking place and area coverage of fruits vegetables and flowers has increased substantially during the last few years. The higher returns from the high value crops therefore supports commercialization and diversification of small farms within and outside agriculture and their proper integration with

local and global markets. This is intended not only to liberate the small and marginal farmers from the poverty trap, but also to meet the country's growing demands for fruits, vegetables, which generally show rising trends with increasing levels of per-capita income in the economy. Diversification is more prominent in rainfed areas than in irrigated zones. In fact the rainfed areas are becoming the hub of non cereals due to their low water requirement and abundant labour supply.

Prahadeeswaran et al. (2009) studied changing pattern of crop diversification and evidences for commercialization of Agriculture. There are several indices, which explain either concentration or diversification of activities in given time and space by a single quantitative indicator. Important indices used to study the crop diversification are Herfindahl Index (HI), Simpson Index (SI), Ogive Index (OI), Entropy Index (EI), Modified Entropy Index (MEI), and Composite Entropy Index (CEI). Shiyani and Pandya (1998) and Sundaresan et al.(2002) had applied more than one of the above indices to study the diversification of agriculture in Gujarat and Coastal districts of Tamil Nadu, respectively.

Utpal Kumar De and Manabendu Chattopadhya (2010) studied crop diversification by poor peasants and role of infrastructure: Evidence from West Bengal**.** The Herfindahl index, Simpson index, Entropy and Modified entropy index have been computed for 24 districts of West Bengal for the years 1970 - 1973, 1979 - 1982, 1989 - 1992 and 2002 - 2005. The studies revealed that crop diversification in West Bengal have been persisting since 1970. The value of diversification index has increased though not at a very faster rate, but reallocation of land towards a few crops has been taking place continuously. Among the varieties of crops, the growth of summer or boro paddy, potato and mustard cultivation has been accelerating over the past three decades whereas, the cultivation of wheat, other cereals, pulses, jute, sugarcane etc have been declining over the years. Data analyzed separately for different sub-periods also confirm this phenomenon. The level of diversification has also been associated with the large scale inter-district variations. Interestingly, the level of diversification in the relatively backward agricultural districts like

Bankura, Midnapore has taken place at relatively faster pace than the other advanced districts such as Burdwan, Hooghly etc. This is reflected through the decline in coefficient of inter-district variations in diversification indices over the years. Decline in coefficient of variation with respect to diversification indices over the years is an indication that the laggard districts where irrigation and other infrastructure have increased at relatively faster rate, could diversify at relatively faster pace than the advanced districts.

Bidyut Kumar Ghosh (2011) studied the essence of crop diversification : a study of West Bengal Agriculture. He used the Minhas and Parikh substitution and expansion effects methodology. This study revealed that the cropping pattern in West Bengal in terms of allocation of acreage skewed towards food grains. However, during the last fifteen to twenty years some important crops (boro rice, potato, oilseeds, especially mustard) emerged as the main crop for the farmers. The cropping pattern turned against pulses, coarse cereals and sugarcane. It was also found that in the cropping pattern changes, the expansion effect could explain 54.69 per cent of the gross cropped area and the remaining 45.31 per cent of the gross cropped area was due to the substitution effect.

Saraswati Poudel Acharaya (2011) et al. studied crop diversification in Karnataka for a period of 26 years from 1982-83 to 2007-08. Composite Entropy Index (CEI) and multiple linear regression analysis used to analyze the nature and extent of crop diversification in the state. They observed that almost all the crop groups had a higher crop diversification index during post-WTO period than during pre-WTO period, except for oilseeds and vegetable crops. There was a vast increase in diversification of commercial crops after WTO. The value of indices for cereals indicated relatively more diversification in recent years compared to the initial years. The Composite Entropy Index for cereals during pre-WTO and post-WTO was 0.698 and 0.729, respectively. Cereals was ranked first and pulses remained second in the overall crop diversification during the study period. Multiple linear regression and step-wise regression was used to identify the factors responsible for changes in crop diversification. The

result revealed that the major factors responsible for the changes in crop diversification were per capita income, proportion of urban population, proportion of area under HYV of cereals, proportion of gross irrigated area to grossed cropped area, rainfall, average size of holding, market density and fertilizer consumption.

Ananya chakraborthy (2012) studied the Crop Diversification in Murshidabad District, West Bengal: A Spatio-temporal Analysis**.** An attempt has been made to show the changes in the crop diversification regions, during the periods of 1996-1997 and 2006-2007. The study revealed that the Crop Diversification is the multiple cropping system i.e. addition of more crops to the existing cropping system along with use of crop species, that could be refined to manufactured products etc. Region like Murshidabad, which is mostly based on agriculture and occupied by different crops, had both a tendency to specialize and diversify. The technique crop diversification index identifies the areas having a tendency of crop diversification in the study area; it also aids to know the cropping pattern, crop concentration, crop variation etc. Variations of crop diversification in response to fast changing physical and socio-cultural conditions are studied for 1996-1997 and 2006-2007 employing Singh's (1976) index of crop diversification. For block level analysis the technique has been classified into various groups. Rice, jute wheat and mustard along with other pulses are the major crops diversified.

Hrideshwer Gupta (2013) examined the agricultural diversification in India. The study revealed that in year 2007-08, the agriculture sector had achieved an impressive growth of 5.8 percent. However; this high growth could not be maintained in the following two years and agriculture sector fell into the negative zone of -0.1 percent in 2008-09, although this was a year of a record 234.47 million tones food production. The decline in growth of agricultural GDP was primarily due to the fall in the production of agricultural crops such as oilseeds, cotton, Jute and Mesta and sugarcane. In 2009-10, despite experiencing the worst south-west monsoon since 1972 and subsequent significant fall in Kharif food grain production, the growth marginally recovered to 0.4 percent

primarily due to a good Rabi crop. Thus concluded that the significance of agriculture in India arises also from the fact that the development in agriculture is an essential condition for the development of the national economy.

Sikander Kumar and Rakesh Singh (2013) studied crop diversification in Himachal Pradesh with special reference to district Una for a period of 1997-98 to 2007-08 and observed that there exists complete diversification of agriculture in Himachal Pradesh as well as in Una district. The value of Herfindahl diversification index remains equal to zero. This shows that the economy of Himachal Pradesh and district Una was diversified gradually day by day. The area under rice decreased from 1.62 to 1.26 per cent in 2005-06 to 2007-08 whereas area under maize, wheat significantly increased in same time. The area under maize increased from 18.09 per cent to 18.77 per cent and area under wheat increased from 19.09 to 20.27 per cent, whereas area under pulses decreased from 0.46 per cent to 0.36 per cent. The area under other crops like potato, oilseed, mustard, sesamum, onion, sugarcane undergone some variations. There was small rise in the share of vegetables and oilseeds area. In 1997-98 the production of total pulses was 565 metric tones which were decreased to 171 metric tones in 2007-08. This decreased occurred due to the shift of pulses into cereal crops.

Supriya Jadhav et al. (2014) studied diversification, crop concentration, specialization and its determinants in Marathwada region of Maharashtra. The time points at which analysis of cropping pattern done were 1980-81, 1985-86, 1990-91, 1995-96, 2001-2005 and 2010-11. Entropy index (EI), Modified Entropy Index (MEI) and Composite Entropy index (CEI) was used to quantify the crop diversification. The result showed that there exist wide temporal change in cropping pattern i.e., area of sorghum replaced by soybean and soybean attained prestigious position in the cropping pattern of Marathwada region diversified more than that of Aurangabad division. Osmanabad, Parbhani and Nanded districts showed increasing level of diversification while Jalna and Latur districts showed low level of diversification. Aurangabad and Beed are more or less stable in

the case of crop diversification. In case of cereals group, mechanization showed significant impact on crop diversification in Aurangabad district where fertilizer use was significantly effect on crop diversification in Latur district. In the case of oilseed group, percentage of small and marginal land holders in total holding showed positively significant impact on oilseed group in Aurangabad district where average size of holding showed positive significant impact on crop diversification in Latur district.

Suranjana Dasgupta and Sankar Kumar Bhaumik (2014) studied crop diversification and Agricultural growth in West Bengal. They examined the trend and pattern of diversification of the crop sector in West Bengal during the period 1980-81 to 2009-10. In this context, they examined the impact of crop diversification on agricultural growth in West Bengal. It was observed that crop diversification in West Bengal has taken place largely in favour of boro rice, potatoes and oilseeds.

Gore et al. (September 2015) examined the crop diversification in Akola district for a period of 15 years i.e., 1995-96 to 2009-10.Herfindahl index and Entropy index has been used to study the extent of crop diversification. Tahsilwise analysis showed that the area under kharif jowar has found to be decreased in all the tahsils of Akola district. Area under soybean crop was increased in Balapur and Murtijapur tahsils. The under wheat has found to be increased in Akot and Patur tahsils. Cotton still remains as major crop of the district. The diversification from subsistence crop to more commercial crops were took place in selected tahsils.

Dipak Bisai et al (April 2016) analyzed crop diversification with spatio temporal concept over Paschim Medinipur district of West Bengal. In this study, two years data has been used to compare the diversification index. These are 2007-08 and 2010-11. The study reveals that crop diversification index in the Paschim Medinipur district has decreased (39.05 to 38.75) between two considered study periods which varies widely among different blocks. Crop diversification index is very low for Jamboni block accompanished with Aman (mono) crop during 2007-08 while Kharagpur-I block replaced the position during 2010-11. The trend of

positive diversification index is noticed in 11 blocks out of considered 29 blocks with in such a short span of study.

Mudasir Hassan Bhat and Prof. Md Abdus Salam (November 2016) studied nature and extent crop diversification across agro- climatic zones of Jammu and Kashmir for the period of 1982-2012. They observed that coefficient of variations is very low, indicating that index values are almost constant over the entire period of study, implying that diversification process is almost stagnant. The indices value show that the Anantnag, Kulgaom and Pulwama at the top of diversification with interchanging positions across indices. The district Shopian is the least diversified in all index values.

2.4 Structural changes of cropping pattern

Joseph (1996) made an analysis on Kerala agriculture with respect to cropping pattern changes. The study intended to infer upon the evolving structure of the state agriculture. By employing appropriate statistical tools projections of future cropping patterns were made and their long-term socio- economic implications were discussed. By assuming that the past trend in change in crop acreages of major crops would continue, quinquennial time series data on cropping pattern from 1970-71 to 1990-91 were subject to a first order Markov- Chain analysis to obtain the transition probability matrix for cropping pattern changes. The crops considered were rice, tapioca, coconut, rubber, other plantations and cash crops and other crops.

Tripathy and Gowada (1999) made an attempt to apply markov chain analysis to study the structural changes in cropping pattern in Orissa by using macro data of crop proportion for the period of 1975-76 to 1989-90. They have used the data of proportion of area under six crops i.e. rice, coarse cereals, pulses, oilseeds, vegetables and fruit and other crops. They have described the processes of cropping pattern change in the form of a matrix P of first order transition probabilities. The study indicated that rice and pulses were most stable crops in the state. After introduction of new crop production technologies there has been structural change in

cropping pattern of the state. Study reveals that the area under rice major and staple food crop of the people had shown a decreasing trend.

Marawar S. S. et.al. (2002), studied the crop diversification in Vidarbha, Maharashtra, India. Markov chain approach was used to study the crops causing diversification while the Herfindahl and Entropy index was used to determine the extent of crop diversification. The results of the Herfindahl and Entropy index confirmed the existence of crop diversification in Vidarbha during the period 1980-99. The transition probability matrix estimated using Markov chain analysis indicated that there was a shift in area under different crops in 1990-99 and that kharif jowar, paddy and cotton are the most stable crops of Vidarbha.

Rao and Parwez (2005) analyze the transactions of area among different crops in relation to sorghum in six major sorghum-growing states in India. Specifically, the secondary data on area under all major crops were collected for the following six target states: Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra and Rajasthan for a period of 29 years from 1970 to 1998. Only rainy and rainfed crops were analyzed. Data collected for this period were divided into sub-periods by identifying threshold points. For each sub-period, a transition probability matrix was constructed for the state as well as the target districts using Markov chain analysis. Data revealed that the area under rainy sorghum crop declined significantly in all the states and districts. The loss reached a certain plateau during 1990s and that is being continued with a steady decline every year.

Aravind Kammar and H. Basvaraja (2012) studied the structural changes in cropping pattern in Northern traditional zone of Karnataka for a period of 30 years from 1977-78 to 2006-07 which were further divided into two sub-periods as pre-liberalization (1977-78 to 1990-91) and post-liberalization (1991-92 to 2006-07) periods. The Markov chain analysis was used to study the shifts in the shares of crops which facilitated the understanding of the dynamics of crop changes. The results showed that the area under maize and chickpea showed most instability and area under cotton was most stable in period I. While in period II except

for paddy, all the crops considered in the study was shown stability and area under maize was most stable. Cotton was one of the major commercial crop shown higher stability by retaining 63.44 per cent of its previous year's share. Meanwhile cotton lost its area share to groundnut (0.13 per cent) and other crops (36.43 per cent). However cotton gained about 30.77 per cent area from paddy, 23.6 per cent from maize, 19.09 per cent from chick pea and 21.24 per cent from other crops. Paddy lost its area share to jowar (13.52 per cent) and other crop (86.48per cent). Paddy gained mainly from groundnut (27.63 per cent). Jowar retained nearly 71.47 per cent of its area share in period II against of about 38.12 per cent) in period I. Jowar gained its area share from paddy (13.52 per cent), cotton (19.63 per cent) and other crop (3.08 per cent). Maize shown more stability in period II by retaining 73.93 per cent of its previous year's area share. Groundnut retained 72.37 per cent of its previous area share and lost about 27.63 per cent of its area share to paddy. Other crops retained 60.12 per cent of their area share and at the same time they lost their area share to jowar (3.08 per cent), maize (7.85 per cent), chickpea (4.39 per cent) and cotton (24.55 per cent). The cultivation of paddy, wheat, jowar, groundnut and chickpea was less remunerative when compared to maize and cotton.

Ardeshna and Shiyani (2013) examine the dynamics of cropping pattern in Gujarat. The data on area of different crops for the period from 1990-91 to 2007-08 were collected from the Directorate of Agriculture, Government of Gujarat, Gandhi nagar and analyzed for four different periods by using Markov chain. The major findings emerged from the study revealed that any single crop did not retain its area in Gujarat, but the acreage of the crops was continuously shifting from one crop to another crop throughout the period. However, other crops like cumin, tur, rape & mustard, onion, garlic etc. had more retention as compared to groundnut, cotton, bajra, jowar and wheat during the study period indicating its stability in the state. The groundnut remained more stable while the loss of area from major crops towards other crops like maize, castor sesamum, tur, etc. indicated that the cropping pattern of the region moves towards diversification in Saurashtra region. The paddy and maize lost more area to

cotton, wheat and other crops like tur, cumin, potato, etc. in Middle Gujarat. The castor crop had more retention of its area as compared to other crops in North Gujarat. In South Gujarat, the decreasing trend of area under groundnut was observed. There is greater scope for decision making in the selection of crops to put the agriculture on the pedestal of sustainable growth which needs to be considered in research and extension programmes.

2.5 Advantageous crops

Takashi Kurosaki (2003) studied the economics of crop diversification in which he concluded that in order to examine the benefits of diversification, land concentration ratio in tahsils with comparative advantage is computed for selected years. The comparative advantage is approximated by the per acre gross revenue of each crop relative to the average revenue of each crop relative to the average revenue of the remaining crops. If the ratio for a crop increases over time, it implies that area under the crop is being concentrated in tahsils that have comparative advantage in producing a crop over other crops.

Jadhav Varsha Pandurang (2011) studied the economics of crop diversification in Amravati district. She concluded that in order to examine the benefits of diversification land concentration ratio in tahsils of Amravati district with comparative advantage is computed for the period of 1990-91 to 2009-10. The comparative advantage is approximated by the per acre gross revenue of each crop relative to the average revenue of the remaining crops. The results showed that soybean and cotton are the adventitious crops in the selected tahsils during the study period.

Korra Vijaya Lakshmi (2016) studied cropping pattern and crop diversification in Amravati division of Maharashtra for a period of 43 years from 1970-71 to 2013-14. Land concentration ratio in different districts with comparative advantage was computed for last 10 years i.e. from 2004-05 to 2013-14. It was seen that, the land concentration ratio of soybean shoed increasing trend over a period of study. It means soybean was the most advantageous crop in Akola district. Land concentration ratio of cotton showed increasing trend over a period of study in Amravati

district. It means cotton was most advantageous crop in Amravati district. Similarly, in the last decade soybean also showed increasing trend in land concentration ratios. Soybean was also an advantageous crop during last decade. It was revealed that soybean was also most advantageous crop in Buldhana district. In Yavatmal district land concentration of cotton showed increasing trend over a period of study. It means cotton was most advantageous crop in Yavatmal district over other selected crops i.e. jowar, soybean and tur. Similarly in the last five years i.e. 2009-10 to 2013-14 soybean also showed increasing trend in land concentration ratios. Thus soybean was also an advantageous crop in Yavatmal district during the last five years.

CHAPTER III

METHODOLOGY

The object of any investigation is to draw the useful conclusions in the light of objectives of the study in order to arrive the meaningful conclusion. It is essential to the investigator to adopt appropriate method and procedure, keeping in view, this chapter has devoted to explain the methodology adopted to fulfill the objectives of the study. The present study aimed at analyzing the changes in cropping pattern and crop diversification in selected tahsils of Wardha district of Maharashtra.

3.1 Selection of Crops

The major food grain and non food grain crops of Wardha district were selected for the present study. Selected crops occupied more than 80 per cent gross cropped area of districts selected in Wardha district. Thus, present study was confined to major crops with an assumption that excluded crops do not affect cropping pattern and in turn would not vitiate main conclusions of the study. The eight crops were selected purposively for present study like Kharif jowar, Tur, Mung, Udid, Cotton, Soybean, Wheat and Gram.

3.2 Data Collection

For the present study the secondary data were collected from various published sources. Time series secondary data on the area of selected crops, farm harvest prices and other agricultural data were obtained from various published sources. To fulfill all objectives the data were collected for the period of last 10 years from 2005-06 to 2014-15.The following publications were referred for recording the data in present study.

1. District socio-economic review- Wardha district (2005-06 to 2014-15)
2. Seasons and crop reports, agriculture department, Maharashtra State (2005-06 to 2014).
3. Department of Agriculture Maharashtra.
4. For estimating the land concentration ratios of selected crops data was collected from Agricultural Prices and Costs Scheme (APC),

Department of Agricultural Economics and Statistics, Dr. PDKV, Akola.

3.3 Sampling design

For the present study four tahsils were purposively selected out of eight tahsils of Wardha district namely Arvi, Ashti, Devali and Samudrapur.

3.3 Analytical tools and technique

3.3.1 Analysis of changes in cropping pattern

Simple tabular analysis

Cropping pattern of selected tahsils of Wardha district were studied by simple tabular analysis for major crops. Cropping pattern in terms of percentage share of individual crops in gross cropped area were work out at different points of time.

3.3.2 Analysis of growth and instability of major crops

a) Exponential model

For examining the performance of different crops growth rates of area of major crops were estimated using exponential model.

$$Y = ab^t$$

Where,

Y = area of selected crops in ha

a & b = parameters to be estimated from exponential model

CGR = $[Antilog(\log b) - 1] \times 100$

b) Coefficient of variation (C.V)

Coefficient of variation of area were calculated by using the following formula

$$c.v. = \frac{S.D.}{Mean} \times 100$$

c) **Coppocks Instability Index**

To measure the coefficient of instability, Coppocks Instability index was estimated as below

$$m = \frac{\sum[\log(X_{i+1}) - \log(X_i)]}{(N-1)}$$

$$V\ Log = \frac{\sum\{[\log(X_{i+1}) - \log(X_i)] - m\}}{(N-1)}$$

$$\text{Coppocks Index} = [\text{Anti log}(\sqrt{\text{V Log}}) - 1] * 100$$

Where-

X_t = area of crop year't'

N = number of year minus 1

M = The arithmetic mean of the difference between the log of X1 and xt -2 etc.

V log = Log arithmetic variances of the series

3.3.3 Analysis for quantification of crop diversification

Crop diversification Index is indicator for observing and quantifying cropping pattern changes. In order to quantify extent of diversification Herfindahl were computed at different points of time.

a) Herfindahl index (HI)

Herfindahl index was computed by taking the sum of squares of acreage proportion of each crop to the total cropped area.

$$HI = \sum_{i=1}^{N} Pi^2$$

Where,

N= The total number of crops.

Pi= Proportion of acreage under i^{th} crop to total cropped area.

The value of HI is bounded by zero (perfect diversification) and one (complete specification). The value of HI approaches zero as 'N' becomes large and takes value one when only one crop is cultivated.

b) Entropy Index

Entropy index is regarded as an inverse measure of concentration having logarithmic character.

$$EI = \sum_{i=1}^{N} \{Pi \log[\frac{1}{pi}]\}$$

3.3.4 Analysis of structural changes in cropping pattern

Markov Chain Analysis

For the estimation of structural changes of cropping pattern, Markov Chain Analysis was used for time period from 2005-06 to 2014-15 for selected tahsils of Wardha district. Kammar and Basvaraja (2012) also have used similar model to study the structural changes in cropping pattern in northern transitional zone of Karnataka. The model is defined as below.

The Markov Probability Model:

A stochastic process is one analyze a set of trials or experiments probabilistically. For stochastic process if N assumed that the movements (transitions) of objects from one division (possible outcome) to another are governed by a probability mechanism or system. A finite Markov process is a stochastic process whereby the outcome of a given trial t (1=1,2,.. T) depends only on the outcome of the preceding trial (t-1) and this dependence is the same at all stage in the sequence of trials. Consistence with this definition, let

S; represent the r tahsil or possible outcomes; i 1,2….r.

Wit represents the probability that tahsil Si occurs on trial t or the proportion observed in trial t in alternative outcome tahsil i.e. of a multinomial population based on a sample of size n, i.e. Pr (S_{it}).

Pit represent the transitional probability that which denotes the probability that if for any time t the process is in state Si it moves on the next trial to division Sj i.e. Pro (S_{jt} + 1/S_{jt}) = P_{ij}.

P = (P_{ij}) represent the transitional probability matrix which denotes the transitional probability for every pair of tahsil (i, j = 1,2 .... r) and has the following properties.

$0 < P_{ij} < 1$ …….. (1)

and

$\sum P = 1$, for i = 1,2……..r…… (2)

Given this set of notations and definitions for a first order Markov chain the probability of a particular sequence Si on trial t and St on trial t+1 may be represented by Pr (S_{it}t S_{it} + 1) = Pr

(S_{it}) Pr $(S_{it}$ t+1 / $S_{it})$ = Wit P_{jt}…….. (3)

and the probability of being in division j at trial t+1 may be represented by

Pr $(S_j$. t + 1) =$\sum W_{it} P_{it}$or i

W_t t + 1 = $\sum W_{it}P_{tj}$ …….. (4)

The data for the study are the proportion of area under selected crops. These proportions change from year to year as result of the factors like weather, technology, price and other institutional change. It is reasonable to assume that the combined influence of these individually systematic forces approximate to a stochastic proceeds and the propensity of farmers to move from one crop to another differs according to the crop involved in tahsil. If these assumptions are acceptable, then the process of cropping pattern change may be described in the form of a matrix p of first order transitional probabilities. The element of P_{ij} of the matrix indicates the probability of a farmer in crop division in one period will more to crop division j during the following period. The diagonal element P_{ij} measures the probability that the proportion share of j^{th} category of crop were maintained.

Estimation of Transition Probability Matrix:

Equation (4) as a basis for specifying the statistical model for estimating the transition probabilities. If errors are incorporated in equation (4) to account for the difference between the actual and estimated occurance of $(W_j$ t+1), the sample observations assumed to be generated by the following Linear Statistical Model.

$W_{jt} = \sum W_t$ t-1 $P_{ij}+ U_{jt}$……. ….(5)

Or in Matrix form it can be written as

$Y_j = X_jP_j+ U_j$.....(6)

Where -

Y_j is a (T x 1) vectors of observations reflecting the proportion in cropping pattern j in time t, x_j is a (Tx R) matrix of

realized values of the proportion in cropping pattern i in time t-1, P_j is a (rx1) vector of unknown transition parameters to be estimated and U_j is a vector of random disturbances.

3.3.5 Analysis of economics of advantageous crop

Land concentration ratio

In order to examine the benefit of diversification of major crops, land concentration ratio in selected tahsils with comparative advantageous were computed for selected periods. Comparative advantageous is here approximated by the per acre gross revenue of each crop relative to the average revenue of the remaining crop (Takashi Kurosaki, 2003).

(The sum of the areas under the crop of concern in tahsils that were ranked the top four in terms of comparative advantage in yield disparity ranking) / (the sum of the areas under the crop of concern in tahsils that were ranked the bottom four).

CHAPTER IV

SOCIO-ECONOMIC STATUS OF WARDHA DISTRICT

It is proposed here to outline some of the main socio-economic features related to Wardha district. This help for providing the background for the proper assessment and understanding of the studies in the course of investigation. The economic returns from the cultivation of various crops are mainly influenced by the climatic conditions, rainfall and type of soil, study of crop enterprise therefore needs to be undertaken in the light of agro-economic conditions of the study area.

4.1Location of Wardha District

Wardha district is located on the north-eastern side of the state of Maharashtra. The district formed part of the Nagpur district till 1962. Subsequently it was made into a separate district. Wardha district lies between 20 degrees 18 minutes north and 21 degrees 21 minutes north latitudes and 78 degrees 4 minutes east to 79 degrees 15 minutes east longitudes. It occupies an area of 6,289 square kilometers. Wardha district consist of 8 tahsils, viz. Wardha, Seloo, Devali, Arvi, Ashti, Hinganghat, Samudrapur, Karanja.

4.2 Boundaries

It is bounded on the west and north by the Amravati district on the south by Yavatmal district, on the south east by the Chandrapur district and on the east by Nagpur district. The boundaries with the Amravati and Yavatmal districts are identified by the Wardha River. Wardha district is a part of the Nagpur Revenue division along with Bhandara district, Gadchiroli district, Chandrapur and Nagpur district.

4.3Administrative set up

Maharashtra State has six revenue divisions viz., Mumbai, Pune, Nasik, Aurangabad, Amravati and Nagpur. Vidarbha area includes Amravati and Nagpur revenue divisions They comprising eleven districts viz., Buldhana, Akola, Washim, Amravati, Yavatmal, Wardha, Bhandara, Gondia, Chandrapur and Gadchiroli. Washimand Gondia are newly

formed districts bifurcating Akola and Bhandara districts respectively. Nagpur revenue division comprising six districts viz., Bhandara, Chandrapur, Gadchiiroli, Godia, Nagpur and Wardha. The present study is confined to Wardha district including four tahsils viz., Arvi, Ashti, Devali and Samudrapur.

4.4. Agro-climatic conditions

4.4.1Topography and soil

Wardha district basically consists of Deccan Trap lava flows with some patches of Gondwana formations, Lametas and the alluvium along the major river courses. Wardha district is rich in deep black soil, medium deep soil and shallow black soil. The riches tracts are found in the valley of Wardha rivers. This soil swell considerably due to addition of water and dries up with cracks on loosing the moisture. The pH of the soil is 7.5 to 8.5 besides the Wardha river. Near the hill on Southern border, shallow and inferior soil determinates.

4.4.2 Climate and rainfall

The agro-climate of Wardha district is characterized by hot, dry and sub-humid bio-climate with dry summers and mild winters. The district receive its rainfall essentially from the south-west monsoon. This monsoon contributes 85 per cent of the total annual rainfall. The north-east monsoon accounts for 9 per cent while hot weather and cool weather periods accounts for 4 per cent and 2 per cent respectively. Average annual precipitation in Wardha district is 1062.8 mm.

4.5Demographic features

4.5.1 Population

As per the important demographic features of the district as per census 2011, the Wardha district population was 13,00,774 which was 1.16 per cent of total Maharashtra population. Out of the total population 51.38 per cent were male and 48.61 per cent were females. The sex ratio was 946 females for every 1000 males. The density of the district was 206 persons per sq.km. The population growth was recorded at 5.18 per cent when compared to 2001 census which was 15.87 per cent.

Table 4.1: Demographic Particulars of Wardha District

Person	Population (lakhs)			Density (Person/km)	Sex Ratio (No of Female /1000Male)			Literacy (%)			Population growth Since 2001-2011 (%)
	Rural	Urban	Total		Rural	Urban	Total	Rural	Urban	Total	
Total	8,77,474 (67.46)	4,23,300 (32.54)	13,00,774 (100)	206	942	955	946	84.27	92.62	86.99	5.18
Males	4,51,874 (67.61)	2,16,511 (32.39)	6,68,385 (100)					89.93	96.05	91.92	
Females	4,25,600 (67.3)	2,06,789 (32.7)	6,32,389 (100)					78.26	89.04	81.81	

(Source: Directorate of census operation in Maharashtra, 2011)

4.5.2 **Land Utilization Pattern**

The geographical area of the Wardha district is 6,289 thousand hectares and net sown area is 57.95 per cent of the total geographical area, grossed crop area is 68.97 per cent of the total geographical area. The land utilization pattern of Wardha district is presented in Table 4.2.

Table 4.2 Land utilization pattern in Wardha district

Sr. No.	Particular	Area (ha)	Percentage of total area
1	Total geographical area	628900	100
2	Land under forest	62400	9.92
3	Land not available for cultivation	55300	8.79
A	Land put to non agricultural use	45000	7.15
B	Barren and uncultivable land	10300	1.63
4	Land not cultivable other than barren land	62100	9.87
A	Permanent pasture and other grazing land	38300	6.08
B	Land under miscellaneous tree crops	8100	1.28
C	Cultivable waste land	15700	2.49
5	Fallow land	84600	13.45
A	Current fallow	62800	9.98
B	Other fallow	21800	3.46
6	Net area sown	364500	57.95
7	Area sown more than once	69300	11.01
8	Gross cropped area (Kharif+Rabi+Sum.)	433800	68.97

(Source: Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India)

4.6 Cropping Pattern

Data of cropping pattern of Wardha district revealed that soybean, cotton, tur are important crops and occupies a leading position in the cropping pattern of Wardha district (see Table 4.6.1)

Table 4.3 Cropping pattern of Wardha district

Sr. No.	Crop Sown	Wardha District	
		Area (ha)	Percentage to gross cropped area
A	**Kharif**		
1	Paddy	200	0.04
2	Jowar	19800	4.56
3	Bajra	00	00
4	Other cereals	00	00
5	Tur	52400	12.07
6	Mung	280	0.06
7	Udid	220	0.05
8	Pulses	200	0.04
9	Castor	100	0.02
10	Groundnut	3300	0.76
11	Sesamum	400	0.09
12	Sunflower	1000	0.23
13	Soybean	214700	49.49
14	Cotton	80100	18.46
B	**Rabi**		
1	Gram	25900	5.97
2	Wheat	19000	4.37
3	Other rabi pulses	300	0.06
4	Jowar	800	0.18
5	Linseed	100	0.02
6	Mustard	100	0.02
7	Other rabi oilseed crops	200	0.04
C	**Summer**		
1	Summer groundnut	965	0.22
D	**Annual**		
1	Sugarcane	1600	0.36
2	Area under fruit cops	10235	2.35
3	Vegetables	800	0.18
4	Condiments and spices	1100	0.25

(Source: Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India)

4.7 Crop Season and Crop Rotation

There are two important crop seasons i.e. Kharif and Rabi where as in summer season land generally remains fallow and preparatory tillage operations are carried out. The Chinese proverb change your kind rather than land. It indicates the importance of crop rotations. To maintain the fertility status of the soil by improved method, crop rotations are essential for a farmer. Cotton, soybean and jowar are the three important crops grown in kharif season in the district. Mung, udid, rice, tur, groundnut are also grown on fairly large scale. Wheat is an important rabi crop grown in the area, gram also common in rabi season. The manner in which crop rotations are commonly followed in the district are as follows.

Hy. sorghum	-	Gram	-	Cotton
Cotton	-	Mung	-	Wheat
Cotton	-	Hy. Sorghum	-	2 year rotation
Soybean	-	Gram		

4.8 Irrigation resources

The irrigation facilities are necessary to develop the agriculture and necessary for the economic development. Rivers, wells, bandaras and minor projects are the main sources of irrigation in the district.

Table 4.4 Source-wise area under irrigation-Wardha district

Sr. No.	Sources	Area (ha)
1	Surface irrigated area	9067
2	Wells	16700
3	Net area irrigated	25767
4	Net sown area	364500
5	Net irrigated area (NIA) as a percentage of net sown area (NSA)	7.06%

4.9 Input Supply

Agricultural inputs like seed, manure, fertilizers, insecticides, pesticides, etc. required to the farmers are made available to them through number of agricultural service centers established at district level and block levels.

The inputs like seed, manures, fertilizers, insecticides, pesticides, etc. are required by the farmers. Maharashtra State Seed Corporation and other private seed companies supply quality seeds of flowers, vegetables and food grains to the farmers. Quality seeds can be made available to the farmers through number of Agriculture Service Centers, established in Wardha district. The farm input are made available to the farmers by cooperative societies functioning at block level, Panchayat Samiti also provides inputs to the farmers. Co-operative society supply input against the loan sanctioned by DCCB to individual cultivator.

4.10 Credit Supply

The credit supply in Wardha District is done by Primary Agricultural Co-operative Credit Society, Non-agricultural credit Society, Panan Sanstha, Production Society and Social Service Society.

4.11 Marketing and transportation

For the marketing of agricultural produce, agricultural market committies are functioning in the district. Wardha district have facilities of regulated markets. These sub-markets are connected with roads and having facilities of banking, electricity, etc. Wardha city is on Nagpur – Hyadrabad route. Bullock carts, auto and tractors are main means of transportation of agricultural produce and inputs.

MAP OF WARDHA DISTRICT

CHAPTER V

RESULTS AND DISCUSSION

This chapter reveals the results and discussion under the following heads and it is presented as per objectives of the study.

5.1 Changes in cropping pattern

5.2 Growth and instability in area of major crops

5.3 Crop diversification

5.4 Structural changes in cropping pattern

5.5 Identification of advantageous crops

5.1 Changes in cropping pattern

5.1.1 Changes in cropping pattern in Arvi tahsil of Wardha district

The changes in cropping pattern in Arvi tahsil of Wardha district during 2005-06 to 2014-15 are presented in Table 5.1.

In the span of 10 years cropping pattern in Arvi tahsil has changed substantially. The proportion of area under wheat by 3.90 per cent, tur by 19.51 per cent and cotton by 39.50 per cent has been increased while kharif jowar by 2.86 per cent, gram by 0.65 per cent, mung by 0.02 per cent, udid by 0.01 per cent and soybean by 33.49 per cent have been reduced by the end of the year 2014-15. In case of cotton, its share over gross cropped area has increased to 39.50 per cent in 2014-15 from 17.26 per cent in 2005-06 which is emerged as the major crop in the Arvi tahsil. The proportion of area under other crops over gross cropped was highest in 2005-06 i.e. 0.46 per cent of gross cropped area. Percent change over base period 2005-06 of cotton is 99.26 per cent which indicates increase of acreage under this crop. The area of kharif jowar, gram, mung, udid, soybean and other crops have been shifted to cotton. There is positive change in wheat by 51.23 per cent and tur by 29.01 per cent next to cotton over base period 2005-06. The gross cropped area has reduced by 12.93 per cent over base period 2005-06.

Table 5.1 Changes in cropping pattern in Arvi tahsil of Wardha district

(Area in hectare)

Sr. No	Crops	Years										Percentage change over base period (2005-06)
		2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	
1	Kh Jowar	3957 (7.30)	2741 (4.62)	1615 (3.09)	1298 (2.55)	884 (1.72)	832 (1.51)	747 (1.28)	735 (1.27)	702 (1.38)	1348 (2.86)	-65.93
2	Wheat	1218 (2.25)	1775 (2.99)	1844 (3.53)	1546 (3.04)	1541 (3.00)	2270 (4.11)	2560 (4.40)	1912 (3.32)	1853 (3.66)	1842 (3.90)	51.23
3	Gram	3121 (5.76)	3601 (6.07)	3601 (6.88)	1680 (3.30)	979 (1.91)	2035 (3.69)	3140 (5.40)	37703 (6.54)	4659 (9.19)	307 (0.65)	-90.16
4	Tur	7136 (13.17)	7785 (13.12)	8418 (16.09)	8354 (16.42)	8608 (16.76)	9550 (17.29)	9391 (16.15)	9129 (15.83)	9509 (18.76)	9206 (19.51)	29.01
5	Mung	106 (0.20)	106 (0.20)	151 (0.29)	113 (0.22)	94 (0.18)	74 (0.13)	56 (0.10)	56 (0.10)	10 (0.02)	8 (0.02)	-92.45
6	Udid	96 (0.18)	30 (0.05)	64 (0.12)	21 (0.04)	14 (0.03)	17 (0.03)	35 (0.06)	80 (0.14)	4 (0.01)	3 (0.01)	-96.88
7	Cotton	9352 (17.26)	10488 (17.68)	10478 (20.03)	7904 (15.53)	16500 (32.12)	24414 (44.21)	24287 (41.76)	25334 (43.92)	16120 (31.80)	18635 (39.50)	99.26
8	Soybean	28948 (53.43)	32574 (54.90)	25997 (49.70)	29889 (58.73)	22700 (44.19)	16010 (28.99)	17900 (30.78)	16625 (28.82)	17817 (35.15)	15801 (33.49)	-45.42
9	Other crops	249 (0.46)	229 (0.39)	138 (0.26)	84 (0.17)	47 (0.09)	19 (0.03)	42 (0.07)	33 (0.06)	20 (0.04)	25 (0.05)	-89.96
	Gross cropped area	54183 (100.00)	59329 (100.00)	52306 (100.00)	50889 (100.00)	51367 (100.00)	55221 (100.00	58158 (100.00)	57677 (100.00)	50694 (100.00)	47175 (100.00)	-12.93

(Figures in the parenthesis indicates the percentage over gross cropped area)

5.1.2 Changes in cropping pattern in Ashti tahsil of Wardha district

The changes in cropping pattern in Ashti tahsil of Wardha district during 2005-06 to 2014-15 are presented in Table 5.2.

Table 5.2 revealed that cotton and soybean were observed as major crops of the tahsil during 2005-06, constituting 77.11 per cent of the total cropping area. In the span of 10 years cropping pattern has changed substantially. The proportion of area under cotton was 23.48 per cent in the year 2005-06, has increased to 43.35 per cent on 2014-15. In case of soybean, its share in gross cropped area has fallen to the level of 33.41 per cent in 2014-15 from 53.63 per cent in 2005-06. The proportion of area under kharif jowar by 0.48 per cent, gram by 4.73 per cent and other crop has been reduced while wheat by 4.84 per cent, tur by 12.11 per cent, mung by 0.27 and udid by 0.45 per cent have been increased by the end of the year 2014-15. The constant proportion of area under other crops over gross cropped was highest in 2005-06 i.e. 0.98 per cent. Udid crop is being cultivated to the extent of 0.45 per cent of gross cropped area. The percentage change over base period 2005-06 of udid is 365.52 per cent which indicates increase of acreage under this crop. There is positive change in wheat by 8.95 per cent, tur by 16.15 per cent, mung 38.98 and cotton by 38.58 per cent next to soybean over base period 2005-06. The gross cropped area has reduced by 24.94 per cent over base period 2005-06.

Table 5.2 Changes in cropping pattern in Ashti tahsil of Wardha district

(Area in hectare)

Sr. No	Crops	Years										Percentage change over base period (2005-06)
		2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	
1	Kh Jowar	1540 (3.93)	1140 (2.66)	1615 (3.07)	64 (0.21)	154 (0.51)	154 (0.47)	104 (0.32)	101 (0.31)	93 (0.28)	143 (0.48)	-90.71
2	Wheat	1307 (3.33)	2098 (4.89)	2239 (4.26)	1429 (4.76)	1818 (6.03)	3028 (9.24)	1500 (4.68)	1211 (3.77)	1411 (4.35)	1424 (4.84)	8.95
3	Gram	2571 (6.56)	3020 (7.05)	3261 (6.21)	1085 (3.61)	490 (1.62)	1246 (3.80)	2710 (8.46)	3287 (10.92)	3713 (11.46)	1391 (4.73)	-45.90
4	Tur	3065 (7.83)	2977 (6.95)	8418 (16.03)	3449 (11.49)	3837 (12.72)	3926 (11.98)	3780 (11.81)	3501 (10.92)	3543 (10.93)	3560 (12.11)	16.15
5	Mung	59 (0.15)	63 (0.14)	151 (0.28)	47 (0.15)	30 (0.09)	20 (0.06)	30 (0.09)	64 (0.19)	64 (0.19)	82 (0.27)	38.98
6	Udid	29 (0.07)	41 (0.09)	64 (0.12)	32 (0.11)	25 (0.08)	16 (0.04)	11 (0.03)	108 (0.33)	108 (0.33)	135 (0.45)	365.52
7	Cotton	9192 (23.48)	7201 (16.81)	10478 (19.96)	4547 (15.14)	16100 (53.40)	17215 (52.55)	12100 (37.81)	11444 (35.71)	10700 (33.02)	12738 (43.35)	38.58
8	Soybean	20994 (53.63)	25787 (60.21)	25997 (49.52)	19278 (64.22)	7630 (25.31)	7112 (21.71)	11700 (36.56)	12270 (38.28)	12753 (39.36)	9819 (33.41)	-53.23
9	Other crops	387 (0.98)	500 (1.16)	267 (0.51)	84 (0.27)	65 (0.21)	39 (0.11)	61 (0.19)	63 (0.19)	14 (0.04)	90 (0.31)	-76.74
	Gross cropped area	39144 (100.00)	42827 (100.00)	52490 (100.00)	30015 (100.00)	30015 (100.00)	32756 (100.00)	31996 (100.00)	32049 (100.00)	32399 (100.00)	29382 (100.00)	-24.94

(Figures in the parenthesis indicates the percentage over gross cropped area)

Table 5.3 Changes in cropping pattern in Devali tahsil of Wardha district **(Area in hectare)**

Sr. No	Crops	Years										Percentage change over base period (2005-06)
		2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	
1	Kh Jowar	2764 (4.77)	2059 (3.22)	1747 (2.66)	345 (0.56)	345 (0.59)	308 (0.50)	197 (0.31)	1116 (1.80)	638 (1.02)	425 (0.68)	-84.62
2	Wheat	1792 (3.09)	2192 (3.43)	2788 (4.25)	1524 (2.50)	1524 (2.63)	1914 (3.11)	1950 (3.13)	2144 (3.46)	2281 (3.65)	2275 (3.64)	26.95
3	Gram	2845 (4.91)	3610 (5.65	3610 (5.51)	1190 (1.95)	118 (0.20)	1190 (1.93)	2250 (3.61)	1946 (3.14)	2872 (4.59)	2530 (4.05)	-11.07
4	Tur	7528 (13.01)	7872 (12.32)	8629 (13.16)	9139 (14.99)	10072 (17.43)	12382 (20.15)	11080 (17.8)	10505 (16.96)	10718 (17.15)	11216 (17.96)	48.99
5	Mung	64 (0.11)	38 (0.05)	38 (0.06)	38 (0.06)	4 (0.01)	6 (0.01)	40 (0.06)	10 (0.02)	3 (0.01)	4 (0.01)	-93.75
6	Udid	46 (0.08)	46 (0.07)	46 (0.07)	20 (0.03)	4 (0.01)	3 (0.01)	10 (0.02)	6 (0.01)	4 (0.01)	2 (0.01)	-95.65
7	Cotton	12994 (22.45)	15429 (24.15)	16138 (24.62)	11548 (18.95)	21480 (37.18)	25248 (41.10)	23146 (37.19)	23146 (37.37)	22280 (35.65)	23275 (37.27)	79.12
8	Soybean	29704 (51.33)	32486 (50.86)	32486 (49.56)	37086 (60.86)	24200 (41.88)	20371 (33.16)	23500 (37.75)	23040 (37.20)	23674 (37.88)	22686 (36.33)	-23.63
9	Other crops	129 (0.22)	139 (0.21)	60 (0.09)	45 (0.07)	26 (0.04)	5 (0.01)	63 (0.10)	22 (0.04)	25 (0.04)	21 (0.03)	-83.72
	Gross cropped area	57866 (100.00)	63871 (100.00)	65542 (100.00)	60935 (100.00)	57773 (100.00)	61427 (100.00)	62236 (100.00)	61935 (100.00)	62495 (100.00)	62434 (100.00)	7.89

(Figures in the parenthesis indicate the percentage over gross cropped area).

5.1.3 Changes in cropping pattern in Devali tahsil of Wardha district

The changes in cropping pattern in Devali tahsil of Wardha district during 2005-06 to 2014-15 are presented in Table 5.3.

In the span of 10 years cropping pattern has changed substantially. As evident from the Table 5.3 the proportion of area under kharif jowar, gram, mung, udid, soybean and other crops have been decreased, while wheat, tur and cotton have been increased during the study period. In case of cotton, its share over gross cropped area has increased to 37.27 per cent in 2014-15 from 22.45 per cent in 2005-06 which is emerged as the major crop in the tahsil. The proportion of area under kharif jowar over gross cropped has reduced from 4.77 per cent in 2005-06 to 0.68 per cent in 2014-15 and soybean has reduced from 51.33 per cent in 2005-06 to 36.33 per cent in 2014-15. Mung, udid and other crops contributed very negligible proportion i.e. 0.01 per cent, 0.01 per cent and 0.03 per cent respectively. The proportion of area under tur over gross cropped area has increased from 13.01 per cent in 2005-06 to 17.96 per cent in 2014-15. The percentage change over base period 2005-06 of cotton is 79.12 per cent which indicates increase of acreage under this crop. The area of kharif jowar, gram, mung, udid, soybean and other crops have been shifted to cotton. There is positive change in tur by 48.99 per cent and wheat 26.95 per cent next to cotton over base period 2005-06. The gross cropped area has increased by 7.89 per cent over base period 2005-06.

5.1.4 Changes in cropping pattern in Samudrapur tahsil of Wardha district

The changes in cropping pattern in Samudrapur tahsil of Wardha district during 2005-06 to 2014-15 are presented in Table 5.4.

Table 5.4 revealed that cotton contributed 15.41 per cent of gross cropped area during the period of 2005-06. In the span of 10 years copping pattern has changed substantially. The proportion of soybean was 59.13 per cent in 2005-06 and increased to 66.87 per cent in 2008-09 but it has reduced to 26.57 per cent in 2014-15. In case of cotton its share over gross cropped area has increased to 51.72 per cent in 2014-15 from 15.41 per cent in 2005-06.

Table 5.4 Changes in cropping pattern in Samudrapur tahsil of Wardha district

(Area in hectare)

Sr. No	Crops	Years										Percentage change over base period (2005-06)
		2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	
1	Kh Jowar	207 (0.30)	81 (0.11)	31 (0.04)	10 (0.01)	58 (0.07)	15 (0.02)	11 (0.01)	9 (0.01)	7 (0.01)	3 (0.01)	-98.55
2	Wheat	3438 (5.01)	3868 (5.33)	4739 (5.84)	2010 (2.68)	4200 (5.65)	4723 (5.59)	3232 (3.80)	3236 (3.89)	3444 (3.78)	750 (0.83)	-78.18
3	Gram	3271 (4.77)	3659 (5.04)	6320 (7.79)	4050 (5.41)	998 (1.34)	11046 (13.09)	7500 (8.82)	7190 (8.65)	8594 (9.43)	8929 (9.91)	172.97
4	Tur	8902 (12.98)	10793 (14.87)	13165 (16.24)	9400 (12.55)	10167 (13.68)	10167 (12.05)	9241 (10.87)	7639 (9.19)	7135 (7.83)	7854 (8.71)	-11.77
5	Mung	20 (0.03)	16 (0.02)	16 (0.02)	16 (0.02)	16 (0.02)	12 (0.01)	80 (0.09)	27 (0.03)	22 (0.02)	18 (0.02)	-10.00
6	Udid	3 (0.01)	2 (0.01)	5 (0.01)	6 (0.01)	5 (0.01)	9 (0.01)	50 (0.05)	19 (0.02)	13 (0.02)	11 (0.01)	266.67
7	Cotton	10565 (15.41)	10605 (14.61)	9079 (11.20)	8900 (11.88)	19740 (26.56)	34995 (41.48)	36000 (42.07)	34941 (42.07)	36909 (40.51)	46590 (51.72)	340.98
8	Soybean	40539 (59.13)	42202 (58.16)	46338 (57.17)	50058 (66.87)	37980 (51.11)	22325 (26.46)	28480 (33.51)	29500 (35.53)	32769 (35.97)	23931 (26.57)	-40.97
9	Other crops	1605 (2.34)	1334 (1.83)	1347 (1.66)	408 (0.54)	1143 (1.54)	1064 (1.26)	418 (0.49)	475 (0.57)	2215 (2.43)	1996 (2.21)	24.36
	Gross cropped area	68550 (100.00)	72560 (100.00)	81040 (100.00)	74858 (100.00)	74307 (100.00)	84356 (100.00)	85012 (100.00)	83036 (100.00)	91108 (100.00)	90082 (100.00)	31.41

(Figures in the parenthesis indicate the percentage over gross cropped area).

which is emerged as the major crop of the tahsil. There is decrease in the area under kharif jowar, wheat, tur and soybean during the study period i.e. from 0.30 per cent in 2005-06 to 0.01 per cent in 2014-15 of kharif jowar and 5.01 per cent in 2005-06 to 0.83 per cent in 2014-15 of wheat and 12 per cent in 2005-06 to 8.71 per cent in 2014-15 of tur and 59.13 per cent in 2005-06 to 26.57 per cent in 2014-15. The per cent change over base period 20005-06 for cotton is 340.98 per cent which indicate increase of acreage under this crop. The area of kharif jowar, wheat, tur, mung and soybean has been shifted to cotton. There is positive change in udid by 266.67 per cent, gram by 172.97 per cent and other crops by 24.36 per cent next to cotton over base period 2005-06. The gross cropped area has increased by 31.41 per cent over base period 2005-06.

5.2 Growth and instability in area of major crops

5.2.1 Growth rates of area of major crops in selected tahsils of Wardha district

The compound growth rates of area of major crops for Arvi, Ashti, Devali and Samudrapur tahsils of Wardha district are presented in Table5.5.

Table 5.5 Compound growth rates of area of major crops in selected tahsils of Wardha district during 2005-06 to 2014-15

Sr. No.	Crops/Tahsils	Arvi	Ashti	Devali	Samudrapur
1	KhJowar	-13.99***	-26.73**	-16.16*	-31.52***
2	Wheat	3.76	-2.64	1.26	-8.62
3	Gram	-9.69	-0.75	-2.29	12.82
4	Tur	2.79***	-0.91	4.66***	-4.04**
5	Mung	-24.82***	-1.78	-25.62**	5.24
6	Udid	-22.68**	12.61	-29.58***	26.21**
7	Cotton	11.11**	5.70	7.45***	22.57***
8	Soybean	-8.02***	-9.83**	-4.67**	-6.44**
9	Other Crops	-25.19***	-24.75***	-18.67**	0.18

***, **, * denotes statistical significance at 1, 5 and 10 per cent level respectively.

The compound growth rates of area of major crops are calculated for the period of 2005-06 to 2014-15. In case of Arvi tahsil, the growth rates of area of tur was increased significantly by 2.79 per cent and

for kharif jowar it was declined significantly by 13.66 per cent. The growth rates of wheat and gram showed stagnancy during the study period. The growth rates of cotton increased significantly by 11.11 per cent. The growth rates of area under mung, udid, soybean and other crops declined significantly by 24.82 per cent, 22.68 per cent, 8.02 per cent and 25.19 per cent respectively.

In case of Ashti tahsil, the growth rates of area of kharif jowar declined significantly by 26.73 per cent. The growth rates of wheat and all pulses viz. gram, tur, mung and udid and cotton showed stagnancy during study period. The growth rates of area under soybean and other crops declined significantly by 9.83 per cent and 24.75 per cent respectively.

In case of Devali tahsil, the growth rates of area of tur was increased significantly by 4.66 per cent and declined significantly by 16.16 per cent for kharif jowar. The growth rates of wheat and gram showed stagnancy during study period. The growth rates of mung and udid declined significantly by 25.62 per cent and 29.58 per cent respectively and it was increased significantly in case of cotton by 7.45 per cent. The growth rates of soybean and other crops also declined significantly by 4.67 per cent and 18.67 per cent.

In case of samudrapur tahsil, the growth rates of kharif jowar and tur declined significantly by 31.52 per cent and 4.04 per cent. The growth rates of wheat, gram and mung showed stagnancy during study period. The growth rates of udid and cotton increased significantly by 26.21 per cent and 22.57 per cent respectively. The growth rate of soybean declined significantly by 6.44 per cent and it was stagnant in case of other crops.

5.2.2 Coefficient of variation and Coppocks instability index of area of major crops in selected tahsils of Wardha district

Coefficient of variation and Coppocks instability index of area of crops in Arvi, Ashti, Devali and Samudrapur tahsil of Wardha are presented in Table 5.6.

Table 5.6 Coefficient of variation and Coppocks instability index of area of major crops in selected tahsils of Wardha district

Sr. No	Crops	Selected Tahsils							
		Arvi		Ashti		Devali		Samudrapur	
		CV	CII	CV	CII	CV	CII	CV	CII
1	Kh Jowar	71.88	37.78	126.74	203.96	90.24	127.08	145.70	140.49
2	Wheat	20.50	23.66	32.34	46.45	18.82	27.23	36.27	87.58
3	Gram	46.55	164.19	43.28	75.21	40.40	57.96	50.23	161.61
4	Tur	9.21	5.07	39.45	58.22	15.87	8.92	18.72	18.28
5	Mung	59.18	72.12	60.77	82.96	88.20	212.78	82.31	110.60
6	Udid	89.44	221.87	78.20	129.39	104.43	104.87	115.55	115.06
7	Cotton	40.93	38.68	33.82	72.05	25.34	27.41	58.25	34.77
8	Soybean	28.76	19.22	46.48	45.19	20.66	18.24	26.72	27.01
9	Other crops	98.46	61.51	106.87	153.88	86.30	202.39	53.07	123.06

(Figures in percentage)

Note: Coefficient of variation and Coppocks instability index of major crops are calculated for the period of 2005-06 to 2014-15.

In Arvi tahsil, kharif jowar showed high coefficient of variation value of 71.88 per cent than Coppocks instability index 37.78 per cent. This indicates that there was acceleration in area expansion with high instability. For tur Coppocks instability index value 5.07 per cent coupled with high coefficient of variation value 9.21 per cent indicated that there was high instability. For wheat, gram, mung and udid coefficient of variation is less than the Coppocks instability index which indicated least consistency in area and stagnation in area expansion. Coefficient of

variation for cotton, soybean and other crops is 40.93 per cent, 28.76 per cent and 98.46 per cent respectively coupled with low Coppocks instability index of 38.68 per cent, 19.22 per cent and 61.51 per cent for cotton, soybean and other crops. This shows high instability of cotton, soybean and other crops.

From Table 6 it was observed that in Ashti Tahsil, kharif jowar, wheat, gram, tur, mung, udid, cotton and soybean shows high Coppocks instability index with low coefficient of variation. This indicates least consistency in area of these crops in Ashti tahsil with stagnation in area expansion. Only soybean shows high coefficient of variation value of 46.48 per cent coupled with low Coppocks instability index of 45.19 per cent which indicates high area instability of this crop in tahsil.

In Devali tahsil, Coppocks instability index for kharif jowar, wheat, gram was 127.08 per cent, 27.23 per cent and 57.96 per cent respectively with low coefficient of variation value of 90.24 per cent, 18.82 per cent and 40.40 per cent for kharif jowar, wheat and gram. This shows stagnation in area of these crops. Tur and soybean experienced high coefficient of variation value of 15.87 per cent and 20.66 per cent with low coppocks instability index value of 8.92 per cent and 18.24 per cent. This indicated that there was acceleration in area expansion of these crops with high instability. Mung, udid, cotton and other crops shows low coefficient of variation value coupled with high Coppocks instability index value which indicates least consistency of area under these crops.

In Samudrapur tahsil, coefficient of variation value for kharif jowar and cotton was 145.7 per cent and 58.25 per cent with low Coppocks instability index value of 140.49 per cent and 34.77 per cent for kharif jowar and cotton. This shows high instability of these crops in Samudrapur tahsil. Coefficient of variation value for tur and udid was 18.72 per cent and 115.55 per cent with Coppocks instability index value of 18.28 per cent and 115.06 per cent for tur and udid. This indicated less instability. Wheat, gram, mung, soybean and other crops shows low coefficient of variation value with high Coppocks instability index value. This shows least consistency in area of these crops and stagnation in area expansion.

5.3 Crop diversification in selected tahsils of Wardha district

The analysis of changes in cropping pattern indicates that diversification took place in selected tahsils of Wardha district. The level of crop diversification varies in selected districts of Wardha district because of varied agro-climatic conditions and resource endowment of the farms. Hence an attempt was made to examine the level of crop diversification in tahsils of Wardha district at different points of time.

Herfindahl index and Coppocks instability index were used to measure the level of crop diversification in present study.

5.3.1 Measurement of crop diversification by Herfindahl index and Entropy index

Herfindahl Index is also a measure of concentration. The value of Herfindahl index varies from zero to one. It takes the value one when there is complete specialization and value zero when there is perfect diversification. Accordingly it is presented in Table 5.7.

Table 5.7 Measurement of crop diversification by Herfindahl index and Entropy index

Sr. No.	Years	Selected Tahsils							
		Arvi		Ashti		Devali		Samudrapur	
		HI	EI	HI	EI	HI	EI	HI	EI
1	2005-06	0.34	0.6	0.35	0.59	0.33	0.6	0.39	0.55
2	2006-07	0.36	0.59	0.4	0.56	0.34	0.59	0.38	0.55
3	2007-08	0.32	0.61	0.32	0.62	0.33	0.59	0.37	0.56
4	2008-09	0.39	0.54	0.45	0.49	0.43	0.48	0.48	0.46
5	2009-10	0.32	0.59	0.35	0.56	0.33	0.54	0.35	0.55
6	2010-11	0.31	0.59	0.35	0.57	0.32	0.55	0.28	0.63
7	2011-12	0.3	0.6	0.3	0.6	0.31	0.57	0.31	0.59
8	2012-13	0.31	0.6	0.3	0.61	0.31	0.58	0.32	0.58
9	2013-14	0.27	0.63	0.3	0.61	0.3	0.59	0.31	0.6
10	2014-15	0.31	0.57	0.32	0.59	0.31	0.58	0.36	0.55

The Table 5.7 also revealed that in Arvi, Ashti, Devali and Samudrapur tahsils of Wardha district, the value of Herfindahl index were found low i.e. less than 0.5 it means in all selected tahsils diversification took place. The diversification from subsistence crop to more commercial crops were took place in these tahsils.

Entropy index is regarded as an inverse measure of crop concentration having logarithmic character. This measure is applied on acreage proportion to measure the crop diversification. The value of Entropy index varies from zero to one. Zero value of Entropy index indicates perfect specialization whereas value of one shows perfect diversification i.e. it had direct relationship with diversification.

The Table 5.7 revealed that in Arvi, Ashti, Devali and Samudrapur tahsils of Wardha district, the value of Entropy index were found high i.e. more than 0.5 except for year 2008-09, it means in all the selected tahsils of Wardha district viz., Arvi, Ashti, Devali and Samudrapur crop diversification took place over a period of time. Therefore, from the following analysis, the hypothesis has been proved respectively crop diversification is occurred in selected tahsils of Wardha district.

5.4 Structural changes in cropping pattern

5.4.1 Structural changes in cropping pattern in Arvi tahsil of Wardha district

The crops considered for the study were kharif jowar, tur, mung, cotton, soybean and other crops in the selected tahsils. Accordingly, the results of the transition probability matrix for crops in Arvi tahsil of Wardha district for the period of 2005-06 to 2014-15 are presented in the Table 5.8.

Table 5.8 Structural changes in cropping pattern in Arvi tahsil of Wardha district for 2005-06 to 2014-15

	Kh Jowar	Tur	Mung	Cotton	Soybean	Other crops
Kh Jowar	**0.0000**	0.0000	0.0022	0.0000	0.9422	0.0556
Tur	0.0000	**0.2318**	0.0000	0.7682	0.0000	0.0000
Mung	0.0000	0.0000	**0.0092**	0.0000	0.9908	0.0000
Cotton	0.0000	0.1766	0.0000	**0.6649**	0.1585	0.0000
Soybean	0.0490	0.1696	0.0031	0.0000	**0.7782**	0.0001
Other crops	0.0000	0.0000	0.0000	0.0000	1.0000	**0.0000**

It is inferred from the Table 5.8 that kharif jowar and other crops have shown instability. Kharif jowar has lost about 0.22 per cent of its previous years' share to mung, 94.22 per cent to soybean and 5.56 per cent to other crops. Tur has retained 23.18 per cent of its previous years' share of area and lost about 76.82 per cent to cotton. However, tur gained 17.66 per cent area from cotton and about 16.96 per cent from soybean. Mung has retained only 0.92 per cent of its previous years' share of area and lost about 99.08 per cent of its previous years' share to soybean. But it gained its share of 0.31 per cent from soybean. Cotton retained about 66.49 per cent of its previous years' share and lost about 17.66 per cent of its area to tur and about 15.85 per cent to soybean. Cotton gained about 76.82 per cent of area share from tur. Soybean has shown highest stability by retaining 77.82 per cent of its previous years' share. Meanwhile it has lost its area share to kharif jowar (4.90 per cent), tur (16.96 per cent), mung (0.31 per cent) and other crops (0.10 per cent). Other crops failed to retain their previous years' area share. They lost their previous years' share to soybean (100.00 per cent). But they gained about 5.56 per cent area share from kharif jowar and about 0.01 per cent from soybean.

5.4.2 Structural changes in cropping pattern. in Ashti tahsil of Wardha district

The results of the transition probability matrix for major crops in Ashti tahsil of Wardha district for the period of 2005-06 to 2014-15 are presented in the Table 5.9.

Table 5.9 Structural changes in cropping pattern in Ashti tahsil of Wardha district for 2005-06 to 2014-15

	Kh Jowar	Tur	Mung	Cotton	Soybean	Other Crop
Kh Jowar	**0.0000**	0.0000	0.0000	0.0000	1.0000	0.0000
Tur	0.0000	**0.0300**	0.0000	0.0000	0.9700	0.0000
Mung	0.0000	0.0000	**0.0000**	0.0000	1.0000	0.0000
Cotton	0.0025	0.1543	0.0000	**0.8432**	0.0000	0.0000
Soybean	0.0019	0.1549	0.0047	0.0963	**0.7323**	0.0099
Other Crop	1.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**

The results in the Table 5.9 revealed that kharif jowar, mung and other crops have shown instability. Kharif jowar lost its majority of area share to soybean (100.00 per cent). However it has gained mainly from cotton (0.25 per cent), soybean (0.19 per cent) and other crops (100.00 per cent). Tur has retained only 3.00 per cent of its previous years' share and lost about 97.00 per cent of its previous years' area share to soybean. Mung was unable to retain its previous years' acreage and lost about 100.00 per cent of area to soybean. Cotton as one of the major commercial crop has shown stability by retaining 84.32 per cent of its previous years' share. Meanwhile it has lost its previous years' area share to kharif jowar (0.25 per cent) and tur (15.43 per cent). Soybean retained 73.23 per cent of its previous years' area share and gained about 100.00 per cent of area from kharif jowar, 97.00 per cent from tur and 100.00 per cent from mung. Other crops failed to retain their previous years' share. But it gained 0.99 per cent area share from soybean and lost about 100.00 per cent of its previous years' are to kharif jowar.

5.4.3 Structural changes in cropping pattern in Devali tahsil of Wardha district

The results of the transition probability matrix for crops in Devali tahsil of Wardha district for the period of 2005-06 to 2014-15 are presented in the Table 5.10.

Table 5.10 Structural changes in cropping pattern in Deavli tahsil of Wardha district

	Kh Jowar	Tur	Mung	Cotton	Soybean	Other crops
Kh Jowar	**0.3399**	0.0000	0.0090	0.0000	0.6463	0.0048
Tur	0.0000	**0.0000**	0.0000	1.0000	0.0000	0.0000
Mung	1.0000	0.0000	**0.0000**	0.0000	0.0000	0.0000
Cotton	0.0000	0.3616	0.0000	**0.5175**	0.1209	0.0000
Soybean	0.0104	0.1062	0.0004	0.0000	**0.8830**	0.0000
Other crops	0.6614	0.0000	0.0000	0.0000	0.0000	**0.3386**

From the Table 5.10 it is observed that, kharif jowar retained about 33.99 per cent of its previous years' share and lost about 0.90 per cent of its previous years' area share to mung, about 64.63 per cent to soybean and about 0.48 per cent to other crops. It has gained about 100.00 per cent of area share from mung, 1.04 per cent from soybean and 66.14 per cent from other crops. Tur was unable to retain its previous years' area share. However, it has lost about 100.00 per cent of area to cotton and gained about 36.16 per cent of area from cotton and 10.62 per cent from soybean. Mung has shown instability. It has lost about 100.00 per cent of area share to kharif jowar and gained only about 0.90 per cent of area from kharif jowar and about 0.04 per cent from soybean. Cotton has retained about 51.75 per cent of its previous years' area share and gained about 100.00 per cent of area share from tur. But it has lost about 36.16 per cent of its area share to tur and 12.09 per cent to soybean. Soybean

has shown highest stability by retaining 88.30 per cent of its previous years' area share. Meanwhile it has gained 64.63 per cent of area from kharif jowar and about 12.09 per cent from cotton and lost about 1.04 per cent to khaif jowar, 10.62 per cent to tur and about 0.04 per cent to mung. Similarly other crops retained about 33.86 per cent of their previous years' area share and gained about 0.48 per cent of area share from kharif jowar. But they lost their area to kharif jowar (66.14 per cent).

5.4.4 Structural changes in cropping pattern in Samudrapur tahsil of Wardha district

The results of the transition probability matrix for crops in Samudrapur tahsil of Wardha district for the period of 2005-06 to 2014-15 are presented in the Table 5.11.

Table 5.11 Structural changes in cropping pattern in Samudrapur tahsil of Wardha district

	Kh Jowar	Tur	Mung	Cotton	Soybean	Other crops
Kh Jowar	**0.0000**	1.0000	0.0000	0.0000	0.0000	0.0000
Tur	0.0000	**0.2679**	0.0000	0.0000	0.7319	0.0002
Mung	0.0000	0.1354	**0.0919**	0.7727	0.0000	0.0000
Cotton	0.0000	0.0090	0.0003	**0.9893**	0.0000	0.0014
Soybean	0.0004	0.1757	0.0002	0.0000	**0.8237**	0.0001
Other crops	0.0000	0.0000	0.0432	0.8769	0.0000	**0.0799**

The results in the Table 5.11 indicated that, kharif jowar shown instability. It was unable to retain its previous years' area share. In had lost about 100.00 per cent of its previous years' area share to tur and gained only 0.04 per cent of area share from soybean. Tur retained about 26.79 per cent of its previous years' area share. However it has gained about 100.00 per cent of area share from kharif jowar, about 13.54 per cent from mung and 17.57 per cent soybean. But it has lost about 73.19 per cent of its previous years' area share to soybean and about 0.02 per cent to other crops. Mung retained only 9.19 per cent of its previous years' area

share. It has gained area from cotton (0.03 per cent), soybean (0.02 per cent) and other crops (4.32 per cent). Mung has lost its area share to tur (13.5 per cent) and cotton (77.27 per cent). Cotton as one of the major commercial crop has highest stability by retaining about 98.93 per cent of its previous years' area share. Meanwhile it has lost its area share to tur (0.90 per cent), mung (0.03 per cent) and other crops (0.14 per cent). However it has gained about 77.27 per cent of area from mung and about 87.69 per cent from other crops. Soybean has retained about 82.37 per cent of its previous years' area share and it has gained about 73.19 per cent of area from tur. But it has lost its area share to kharif jowar (0.04 per cent), tur (17.57 per cent), mung (0.02 per cent) and other crops (0.01 per cent). Similarly other crops have retained about 7.99 per cent of their previous years' area share. It has gained area from tur (0.02 per cent), cotton (0.14 per cent) and soybean (0.01 per cent). Meanwhile they have lost their area to mung (4.32 per cent) and cotton (87.69 per cent).

5.5 Identification of advantageous crops

5.5.1 Identification of advantageous crops in selected tahsils of Wardha district

In order to examine the benefits of diversification, land concentration ratios of Arvi, Ashti, Devali and Samudrapur tahsils of Wardha district were computed and presented in Table 5.12 to 5.15.

Table 5.12 Land concentration ratios of major crops in Arvi tahsil of Wardha district

Sr. No.	Years/Crops	Kh. Jowar	Tur	Cotton	Soybean
1	2005-06	0.36	1.37	1.07	1.40
2	2006-07	0.35	0.90	1.37	1.63
3	2007-08	0.36	1.13	1.40	1.29
4	2008-09	0.30	1.19	1.64	1.12
5	2009-10	0.30	1.62	1.67	0.76
6	2010-11	0.25	2.01	1.15	0.97
7	2011-12	0.30	1.71	1.39	0.89
8	2012-13	0.30	1.41	1.54	1.01
9	2013-14	0.53	1.07	1.57	0.96
10	2014-15	0.54	1.08	2.04	0.65

Land concentration ratios of major crops of Arvi tahsil were presented in Table 5.12. From the table it is observed that, the land concentration ratio of cotton showed increasing trend over a period of study. It means cotton is most advantageous crop over other selected crops i.e. kharif jowar, soybean and tur in Arvi tahsil of Wardha district.

Table 5.13 Land concentration ratios of major crops in Ashti tahsil of Wardha district

Sr. No.	Years/Crops	Kh Jowar	Tur	Cotton	Soybean
1	2005-06	0.70	2.30	1.88	2.04
2	2006-07	0.81	2.11	1.84	2.09
3	2007-08	0.59	2.40	1.61	2.43
4	2008-09	0.69	2.26	3.10	1.12
5	2009-10	0.76	2.11	2.62	1.47
6	2010-11	0.71	2.73	2.59	1.11
7	2011-12	0.73	2.78	2.42	1.17
8	2012-13	0.87	2.35	2.48	1.26
9	2013-14	0.75	2.53	2.46	1.28
10	2014-015	0.71	3.30	2.59	0.79

Land concentration ratios of major crops in Ashti tahsil were presented in Table 13. From the table, it is seen that the land concentration ratio of cotton showed increasing trend over a period of study. It means cotton is most advantageous crop over other selected crops i.e. kharif jowar, tur and soybean in Ashti tahsil of Wardha district. Tur also shows increasing trend of land concentration ratio. So tur is also advantageous crop next to cotton in Ashti tahsil.

Table 5.14 Land concentration ratios of major crops in Devali tahsil of Wardha district

Sr. No.	YEAR	Kh. Jowar	Tur	Cotton	Soybean
1	2005-06	0.30	1.57	1.01	1.37
2	2006-07	0.39	0.70	1.12	2.20
3	2007-08	0.33	0.99	1.36	1.56
4	2008-09	0.35	1.18	1.46	1.20
5	2009-10	0.39	0.87	1.47	1.48
6	2010-11	0.13	3.49	0.75	0.85
7	2011-12	0.16	2.36	1.37	0.73
8	2012-13	0.25	2.81	0.68	1.03
9	2013-14	0.42	1.38	1.08	1.28
10	2014-15	0.65	0.95	1.24	1.22

Land concentration ratios of major crops in Devali tahsil were presented in Table 5.14. From the table, it is seen that the land concentration ratio of cotton showed increasing trend over a period of study. It means cotton is most advantageous crop over other selected crops i.e. kharif jowar, soybean and tur in Devali tahsil of Wardha district.

Table 5.15 Land concentration ratios of major crops in Samudrapur tahsil of Wardha district

Sr. No.	YEAR	Kh Jowar	Tur	Cotton	Soybean
1	2005-06	0.34	1.30	0.76	1.96
2	2006-07	0.34	0.82	0.93	2.44
3	2007-08	0.17	1.25	0.95	2.11
4	2008-09	0.38	1.66	1.66	0.64
5	2009-10	0.56	0.82	2.52	0.62
6	2010-11	0.19	1.87	0.80	1.59
7	2011-12	0.12	1.68	1.18	1.42
8	2012-13	0.16	0.72	1.92	1.73
9	2013-14	0.09	0.66	1.57	2.42
10	2014-15	0.09	1.10	1.74	1.52

Land concentration ratios of major crops in Samudrapur tahsil of Wardha district were presented in Table 5.15. From the table, it is seen that the land concentration ratio of cotton showed increasing trend over a period of study. It means cotton is most advantageous crop over other selected crops i.e. kharif jowar, soybean and tur in Samudrapur tahsil of Wardha district.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The study of crop diversification and changes in cropping pattern assumes a great significance as it is one of the important path for balanced development of agriculture to meet the human requirements. The adoption of better cropping pattern optimally suited to the technological changes is an important one for augmenting agricultural growth. Cropping pattern has been dynamic to cope up the changing scenario and to meet the ever changing demand of growing population. Limited availability of land to rising population and declining yields, forced farmers to search for alternative ways for raising farm income. With the passage of time farmers became increasingly commercialized and started farming for maximizing their output. Now the realization prevails amongst the farmers for long term returns and they are in search of optimum cropping pattern which can fulfill their aspirations. So in this context, an effort has been made to examine the change in cropping pattern, extent of crop diversification and economics of crop diversification in selected tahsils of Wardha district. The specific objectives of this study were as under.

1. To study the changes in cropping pattern in selected tahsils of Wardha District.
2. To estimate the growth and instability in area of major crops in selected tahsils.
3. To study the crop diversification in selected tahsils.
4. To study the structural changes in cropping pattern in selected tahsils.
5. To identify the advantageous crop in selected tahsils.

The present study based on secondary data collected from different government publications. The time series data on area of selected tahsils of Wardha district were collected for the period 2005-06 to 2014-15.

The crops selected for the study were Wheat, Soybean, Cotton, Kharif Jowar, Gram, Tur, Mung, Udid.

Various statistical techniques were used to achieve the objectives of study. In order to examine the changes in cropping pattern in selected tahsils of Wardha district i.e. Arvi, Ashti, Devali and Samudrapur, the percentage share of individual crops with respect to gross cropped area has been worked out at different points of time. In order to examine the growth and instability of different crops in selected tahsils of Wardha district compound growth rates, coefficient of variation and Coppocks instability index have been computed at different points of time. In order to study the extent of crop diversification in selected tahsils of Wardha district Herfindahl index and Entropy index have been computed at different points of time. In order examine structural changes in cropping in selected tahsils of Wardha district, Markov chain analysis were carried out at different points of time. In order to work out the advantageous crops, land concentration ratios with comparative advantage was computed for selected crops at different points of time. The results of the study are summarized as below.

6.1 Changes in cropping pattern in selected tahsils of Wardha district

The analysis of cropping pattern changes in selected tahsils of Wardha district revealed that cotton, soybean were the major crops in selected tahsils of Wardha district. Cotton is one of the major crops of all the selected tahsils of Wardha district. Tahsil wise proportions of area under cotton in 2014-15 were Arvi (39.50 per cent), Ashti (43.35 per cent), Devali (37.27 per cent) and Samudrapur (51.72 per cent). The area under soybean is found to be decreasing in selected tahsils (i.e. study area) of Wardha district.

6.2 Growth and instability of major crops in selected tahsils of Wardha district

Compound growth rates of area of major crops in selected tahsils of Wardha district revealed that, during the study period growth rates of area were declined significantly in case of kharif jowar i.e. in Arvi tahsil by 13.66 per cent, in Ashti tahsil by 26.73 per cent, in Devali tahsil by 16.16 per cent and in Samudrapur tahsil by 31.52 per cent. Among pulses the area growth rate of tur increased significantly while miung and udid declined significantly. The growth rate of cotton increased significantly by 11.11 per cent in Arvi, by 7.45 per cent in Devali and by 22.57 per cent in Samudrapur while it was stagnant in Ashti. Growth rate of Soybean declined significantly and wheat increased significantly in all selected tahsils of Wardha district. Kharif jowar, soybean, cotton have high instability while wheat, gram, tur, mung and udid have stagnancy in area expansion in all the selected tahsils of Wardha district.

6.3 Crop diversification in selected tahsils of Wardha district

In selected tahsils of Wardha district i.e. Arvi, Ashti, Devali and Samudrapur crop diversification has occurred during the study period. The diversification from subsistence crop to more commercial crops were took place in these tahsils.

6.4 Structural changes in cropping pattern in selected tahsils of Wardha district

The analysis of structural changes in cropping pattern in selected tahsils of Wardha district revealed that cotton and soybean retained their previous years' area share. They are also highest gainer of area share. Cotton and soybean showed stability in area share during the study period in all the selected tahsils of Wardha district. Majority of area of kharif jowar, mung and other crops were gained by cotton and soybean.

6.5 Advantageous crops in selected tahsils of wardha district

Land concentration ratio of cotton is increasing from year 2005-06 to 2014-15. So, cotton is most advantageous crop over other selected crops in Arvi, Ashti, Devali and Samudrapur tahsil of Wardha district.

Conclusions

1. Area under kharif jowar has reduced in selected tahsils of Wardha from 2005-06 to 2014-15.
2. Proportion of area under cotton has increased and soybean has reduced in selected tahsils of wardha district.
3. Area growth rates of cotton were positively significant in Arvi, Ashti, Devali and Samudrapur tahsils of Wardha district at 1 per cent level of significance.
4. Over a period of study cropping pattern has changed and crop diversification has occurred in selected tahsils of Wardha district.
5. Cotton and soybean showed most stability and have retained their previous years' area share in selected tahsils of Wardha district.
6. Cotton is most advantageous crop over other crops in Arvi, Ashti, Devali and Samudrapur tahsils of Wardha district.

Policy Implication

The following policy implications are brought out from important findings of present study.

1. Crop diversification has occurred over the period of study in all the selected tahsils of Wardha district. This should be noted while deciding the policy on cropping plan for these tahsils.
2. Area of Food grains crops have been observed declining trend over a period of time, therefore Government should motivate the farmers to cultivate food grains crops through providing marketing facilities, price policy and providing low cost agricultural technology at cheapest cost, etc . So as to farmers get benefitted by cultivating food grains crop.

CHAPTER VII

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APPENDIX I

Compound growth rates of area of major crops in Arvi tahsils of Wardha district

(Area in ha)

Sr. No.	Year	Kh Jowar	Wheat	Gram	Tur	Mung	Udid	Cotton	Soybean	Other crops
1	2005-06	3957	1218	3121	7136	106	96	9352	28948	12473
2	2006-07	2741	1775	3601	7785	106	30	10488	32574	14089
3	2007-08	1615	1844	3601	8418	151	64	10478	25997	14079
4	2008-09	1298	1546	1680	8354	113	21	7904	29889	9584
5	2009-10	884	1541	1790	8608	94	14	16500	22700	18290
6	2010-11	832	2270	2035	9550	74	17	24414	16010	26449
7	2011-12	747	2560	3140	9391	56	35	24287	17900	27427
8	2012-13	735	1912	3773	9129	56	80	25334	16625	29107
9	2013-14	702	1853	4659	9509	10	4	16120	17817	20779
10	2014-15	1348	1842	307	9206	8	3	18635	15801	18942
	CGR	-13.99***	3.76***	-9.69***	2.79**	-24.82***	-22.7***	11.11***	-8.02***	-25.19***

***, **, * denotes statistical significance at 1, 5 and 10 per cent level respectively.

APPENDIX II

Compound growth rates of area of major crops in Ashti tahsils of Wardha district

(Area in ha)

Sr. No.	Year	Kh Jowar	Wheat	Gram	Tur	Mung	Udid	Cotton0	Soybean	Other crops
1	2005-06	1540	1307	2571	3065	59	29	9192	20994	23565
2	2006-07	1140	2098	3020	2977	63	41	7201	25787	28807
3	2007-08	1615	2239	3261	8418	151	64	10478	25997	29258
4	2008-09	64	1429	1085	3449	47	32	4547	19278	20363
5	2009-10	154	1818	1186	3837	30	25	16100	7630	8816
6	2010-11	154	3028	1246	3926	20	16	17215	7112	8358
7	2011-12	104	1500	2710	3780	30	11	12100	11700	14410
8	2012-13	101	1211	3287	3501	64	108	11444	12270	15557
9	2013-14	93	1411	3713	3543	64	108	10700	12753	16466
10	2014-15	143	1424	1391	3560	82	135	12738	9819	11210
	CGR	-26.73***	-2.64**	-0.75	-0.91	-1.78	12.61***	5.70***	-9.83***	-24.75***

***, **, * denotes statistical significance at 1, 5 and 10 per cent level respectively.

APPENDIX III

Compound growth rates of area of major crops in Devali tahsils of Wardha district

(Area in ha)

Sr. No.	Year	Kh Jowar	Wheat	Gram	Tur	Mung	Udid	Cotton	Soybean	Other crops
1	2005-06	2764	1792	2845	7528	64	46	12994	29704	29750
2	2006-07	2059	2192	3610	7872	38	46	15429	32486	32532
3	2007-08	1747	2788	3610	8629	38	46	16138	32486	32532
4	2008-09	345	1524	1190	9139	38	20	11548	37086	37106
5	2009-10	345	1524	1190	10072	4	4	21480	24200	24204
6	2010-11	308	1914	1190	12382	6	3	25248	20371	20374
7	2011-12	197	1950	2250	11080	40	10	23146	23500	23510
8	2012-13	1116	2144	1946	10505	10	6	23146	23040	23046
9	2013-14	638	2281	2872	10718	3	4	22280	23674	23678
10	2014-15	425	2275	2530	11216	4	2	23275	22686	22688
	CGR	-16.16***	1.26	-2.29*	4.66***	-25.62***	-29.58***	7.45***	-4.67***	-18.67***

***, **, * denotes statistical significance at 1, 5 and 10 per cent level respectively.

APPENDIX IV

Compound growth rates of area of major crops in Samudrapuri tahsils of Wardha district

(Area in ha)

Sr. No.	Year	Kh Jowar	Wheat	Gram	Tur	Mung	Udid	Cotton	Soybean	Other crops
1	2005-06	207	3438	3271	8902	20	3	10565	40539	40559
2	2006-07	81	3868	3659	10793	16	2	10605	42202	42218
3	2007-08	31	4739	6320	13165	16	5	9079	46338	46354
4	2008-09	10	2010	4050	9400	16	6	8900	50058	50074
5	2009-10	58	4200	998	10167	16	5	19740	37980	37996
6	2010-11	15	4723	11046	10167	12	9	34995	22325	22337
7	2011-12	11	3232	7500	9241	80	50	36000	28480	28560
8	2012-13	9	3236	7190	7639	27	19	34941	29500	29527
9	2013-14	7	3444	8594	7135	22	13	36909	32769	32791
10	2014-15	3	750	8929	7854	18	11	46590	23931	23949
	CGR	-31.5***	-8.62***	12.82***	-4.035***	5.24***	26.21***	22.57***	-6.44***	0.18

***, **, * denotes statistical significance at 1, 5 and 10 per cent level respectively.

APPENDIX V

Coefficient of variation and Coppocks instability index of area of major crops in Arvi tahsils of Wardha district.

(Area in ha)

Sr. No.	Year	Kh Jowar	Wheat	Gram	Tur	Mung	Udid	Cotton	Soybean	Other crops
1	2005-06	3957	1218	3121	7136	106	96	9352	28948	12473
2	2006-07	2741	1775	3601	7785	106	30	10488	32574	14089
3	2007-08	1615	1844	3601	8418	151	64	10478	25997	14079
4	2008-09	1298	1546	1680	8354	113	21	7904	29889	9584
5	2009-10	884	1541	1790	8608	94	14	16500	22700	18290
6	2010-11	832	2270	2035	9550	74	17	24414	16010	26449
7	2011-12	747	2560	3140	9391	56	35	24287	17900	27427
8	2012-13	735	1912	3773	9129	56	80	25334	16625	29107
9	2013-14	702	1853	4659	9509	10	4	16120	17817	20779
10	2014-15	1348	1842	307	9206	8	3	18635	15801	18942
	CV (%)	71.88	20.5	46.55	9.21	59.18	89.4	40.93	28.76	98.46
	CII (%)	37.78	23.66	164.19	5.07	72.12	222	38.68	19.22	61.51

APPENDIX VI

Coefficient of variation and Coppocks instability index of area of major crops in Ashti tahsils of Wardha district.

(Area in ha)

Sr. No.	Year	Kh Jowar	Wheat	Gram	Tur	Mung	Udid	Cotton	Soybean	Other crops
1	2005-06	1540	1307	2571	3065	59	29	9192	20994	23565
2	2006-07	1140	2098	3020	2977	63	41	7201	25787	28807
3	2007-08	1615	2239	3261	8418	151	64	10478	25997	29258
4	2008-09	64	1429	1085	3449	47	32	4547	19278	20363
5	2009-10	154	1818	1186	3837	30	25	16100	7630	8816
6	2010-11	154	3028	1246	3926	20	16	17215	7112	8358
7	2011-12	104	1500	2710	3780	30	11	12100	11700	14410
8	2012-13	101	1211	3287	3501	64	108	11444	12270	15557
9	2013-14	93	1411	3713	3543	64	108	10700	12753	16466
10	2014-15	143	1424	1391	3560	82	135	12738	9819	11210
	CV (%)	126.74	32.34	43.28	39.45	60.77	78.2	33.82	46.48	106.87
	CII (%)	203.96	46.45	75.21	58.22	82.96	129.39	72.05	45.19	153.88

APPENDIX VII

Coefficient of variation and Coppocks instability index of area of major crops in Devali tahsils of Wardha district.

(Area in ha)

Sr. No.	Year	Kh Jowar	Wheat	Gram	Tur	Mung	Udid	Cotton	Soybean	Other crops
1	2005-06	2764	1792	2845	7528	64	46	12994	29704	29750
2	2006-07	2059	2192	3610	7872	38	46	15429	32486	32532
3	2007-08	1747	2788	3610	8629	38	46	16138	32486	32532
4	2008-09	345	1524	1190	9139	38	20	11548	37086	37106
5	2009-10	345	1524	1190	10072	4	4	21480	24200	24204
6	2010-11	308	1914	1190	12382	6	3	25248	20371	20374
7	2011-12	197	1950	2250	11080	40	10	23146	23500	23510
8	2012-13	1116	2144	1946	10505	10	6	23146	23040	23046
9	2013-14	638	2281	2872	10718	3	4	22280	23674	23678
10	2014-15	425	2275	2530	11216	4	2	23275	22686	22688
	CV (%)	90.24	18.82	40.4	15.87	88.2	104.4	25.34	20.66	86.3
	CII (%)	127.08	27.23	57.96	8.92	212.8	104.9	27.41	18.24	202.39

APPENDIX VIII

Coefficient of variation and Coppocks instability index of area of major crops in Samudrapur tahsils of Wardha district.

(Area in ha)

Sr. No.	Year	Kh Jowar	Wheat	Gram	Tur	Mung	Udid	Cotton	Soybean	Other crops
1	2005-06	207	3438	3271	8902	20	3	10565	40539	40559
2	2006-07	81	3868	3659	10793	16	2	10605	42202	42218
3	2007-08	31	4739	6320	13165	16	5	9079	46338	46354
4	2008-09	10	2010	4050	9400	16	6	8900	50058	50074
5	2009-10	58	4200	998	10167	16	5	19740	37980	37996
6	2010-11	15	4723	11046	10167	12	9	34995	22325	22337
7	2011-12	11	3232	7500	9241	80	50	36000	28480	28560
8	2012-13	9	3236	7190	7639	27	19	34941	29500	29527
9	2013-14	7	3444	8594	7135	22	13	36909	32769	32791
10	2014-15	3	750	8929	7854	18	11	46590	23931	23949
	CV (%)	145.7	36.27	50.23	18.72	82.31	115.6	58.25	26.72	53.07
	CII (%)	140.5	87.58	161.61	18.28	110.6	115.1	34.77	27.01	123.06